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I. CREATION BY LAW.

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Among the various criticisms that have appeared on Mr. Darwin's celebrated "Origin of Species," there is, perhaps, none that will appeal to so large a number of well educated and intelligent persons as that contained in the Duke of Argyll's "Reign of Law." The noble author represents the feelings and expresses the ideas of that large class who take a keen interest in the progress of Science in general, and especially that of Natural History, but have never themselves studied nature in detail, or acquired that personal knowledge of the structure of closely allied forms,—the wonderful gradations from species to species and from group to group, and the infinite variety of the phenomena of "variation" in organic beings,—which are absolutely necessary for a full appreciation of the facts and reasonings contained in Mr. Darwin's great work.

Nearly half of the Duke's book is devoted to an exposition of his idea of 'Creation by Law,' and he expresses so clearly what are his difficulties and objections as regards the theory of "Natural Selection," that I think it advisable that they should be fairly answered, and that his own views should be shown to lead to conclusions as hard to accept as any which he imputes to Mr. Darwin.

The point on which the Duke of Argyll lays most stress is, that proofs of Mind everywhere meet us in Nature, and are more especially manifest wherever we find "contrivance" or "beauty." He maintains that this indicates the constant supervision and direct interference of the Creator, and cannot possibly be explained by the unassisted action of any combination of laws. Now Mr. Darwin's work has for its main object to show, that all the phenomena of living things,—all their wonderful organs and complicated structures, their infinite variety of form, size, and colour, their intricate and involved relations to each other,—may have been produced by

the action of a few general laws of the simplest kind, laws which are in most cases mere statements of admitted facts. The chief of these laws or facts are the following:—

1. *The Law of Multiplication in Geometrical Progression.*—All organized beings have enormous powers of multiplication. Even man, who increases slower than all other animals, could under favourable circumstances double his numbers every ten years, or a thousand-fold in a century. Most animals and plants could increase their numbers from ten to a thousand-fold every year.

2. *The Law of Limited Population.*—The number of living individuals of each species in any country, or in the whole globe, is practically stationary; whence it follows that the whole of this enormous increase must die off almost as fast as produced, except only those individuals for whom room is made by the death of parents. As a simple but striking example, take an oak forest. Every oak will drop annually thousands or millions of acorns, but till an old tree falls, not one of these millions can grow up into a tree. They must die at various stages of growth.

3. *The Law of Heredity, or likeness of offspring to their parents.*—This is a universal, but not an absolute law. All creatures resemble their parents in a high degree, and in the majority of cases very accurately; so that even individual peculiarities of whatever kind in the parents are almost always transmitted to some of the offspring.

4. *The Law of Variation.*—This is fully expressed by the lines:—

> "No being on this earthly ball,
> Is like another, all in all."

Offspring resemble their parents very much, but not wholly—each being possesses its individuality. This "variation" itself varies in amount, but it is always present, not only in the whole being, but in every part of every being. Every organ, every character, every feeling is individual; that is to say, *varies* from the same organ, character, or feeling in every other individual.

5. *The Law of unceasing change of Physical Conditions upon the Surface of the Earth.*—Geology shows us that this change has always gone on in times past, and we also know that it is now everywhere going on.

6. *The Equilibrium of Nature.*—When a species is well adapted to the conditions which environ it,—it flourishes; when imperfectly adapted it decays; when ill-adapted it becomes extinct. If *all* the conditions which determine an organism's well-being are taken into consideration, this statement can hardly be disputed.

This series of facts or laws are mere statements of what is the condition of nature. They are facts or inferences which are

generally known, generally admitted,—but in discussing the subject of the 'Origin of Species,'—as generally forgotten. It is from these universally admitted facts that the origin of all the varied forms of nature may be deduced by a logical chain of reasoning, which, however, is at every step verified and shown to be in strict accord with facts; and, at the same time, a host of curious facts which can by no other means be understood, are explained and accounted for. It is probable that these primary facts or laws are but results of the very nature of life, and of the essential properties of organized and unorganized matter. Mr. Herbert Spencer, in his "First Principles" and his "Biology" has, I think, made us able to understand how this may be; but at present we may accept these laws without going further back, and the question then is—whether the variety, the harmony, the contrivance, and the beauty we perceive in organic beings, can have been produced by the action of these laws alone, or whether we are required to believe in the incessant interference and direct action of the mind and will of the Creator. It is simply a question of how the Creator has worked. The Duke maintains, that he has personally applied general laws to produce effects which those laws are not in themselves capable of producing; that the universe alone, with all its laws intact, would be a sort of chaos, without variety, without harmony, without design, without beauty; that there is not (and therefore we may presume that there could not be) any self-developing power in the universe. I believe, on the contrary, that the universe is so constituted as to be self-regulating; that as long as it contains Life, the forms under which that life is manifested have an inherent power of adjustment to each other and to surrounding nature; and that this adjustment necessarily leads to the greatest possible amount of variety and beauty and enjoyment, because it does depend on general laws, and not on a continual supervision and re-arrangement of details. As a matter of feeling and religion, I hold this to be a far higher conception of the Creator and of the Universe than that which I must call the "continual interference," hypothesis; but it is not a question to be decided by our feelings or convictions, it is a question of facts and of reason. Could the change, which Geology shows us has ever taken place in the forms of life, have been produced by general laws, or does it imperatively require the incessant supervision of a creative mind? This is the question for us to consider, and our opponents have the difficult task of proving their negative, if we show that there are both facts and analogies in our favour.

Mr. Darwin has laid himself open to much misconception, and has given to his opponents a powerful weapon by his continual use of metaphor in describing the wonderful co-adaptations of organic beings.

"It is curious," says the Duke of Argyll, "to observe the language which this most advanced disciple of pure naturalism instinctively uses, when he has to describe the complicated structure of this curious order of plants (the Orchids). 'Caution in ascribing intentions to nature,' does not seem to occur to him as possible. Intention is the one thing which he does see, and which when he does not see, he seeks for diligently until he finds it. He exhausts every form of words and of illustration by which intention or mental purpose can be described. 'Contrivance'—'curious contrivance'—'beautiful contrivance,'—these are expressions which occur over and over again. Here is one sentence describing the parts of a particular species; 'the Labellum is developed into a long nectary, *in order* to attract Lepidoptera, and we shall presently give reason for suspecting that the nectar is *purposely* so lodged, that it can be sucked only slowly *in order* to give time for the curious chemical quality of the viscid matter setting hard and dry.'" Many other examples of similar expressions are quoted by the Duke, who maintains that no explanation of these "contrivances" has been or can be given, except on the supposition of a personal contriver, specially arranging the details of each case, although causing them to be produced by the ordinary processes of growth and reproduction.

Now there is a difficulty in this view of the origin of the structure of Orchids which the Duke does not allude to. The majority of flowering plants are fertilized, either without the agency of insects or, when insects are required, without any very important modification of the structure of the flower. It is evident, therefore, that flowers might have been formed as varied, fantastic, and beautiful as the Orchids and yet have been fertilized by insects, in the same manner as Violets, or Clover, or Primroses or a thousand other flowers. The strange springs and traps and pitfalls found in the flowers of Orchids cannot be necessary *per se*, since exactly the same end is gained in ten thousand other flowers which do not possess them. Is it not then an extraordinary idea to imagine the Creator of the Universe *contriving* the various complicated parts of these flowers as a mechanic might contrive an ingenious toy or a difficult puzzle? Is it not a more worthy conception that they are some of the results of those general laws which were so co-ordinated at the first introduction of life upon the earth as to result necessarily in the utmost possible development of varied forms?

But let us take one of the simpler cases adduced and see if our general laws are unable to account for it.

"There is a Madagascar Orchis—the Angræcum sesquipedale—with an immensely long and deep nectary. How did such an extraordinary organ come to be developed? Mr. Darwin's explana-

tion is this. The pollen of this flower can only be removed by the proboscis of some very large moths trying to get at the nectar at the bottom of the vessel. The moths with the longest proboscis would do this most effectually; they would be rewarded for their long noses by getting the most nectar; whilst on the other hand, the flowers with the deepest nectaries would be the best fertilized by the largest moths preferring them. Consequently, the deepest nectaried Orchids and the longest nosed moths would each confer on the other a great advantage in the 'battle of life.' This would tend to their respective perpetuation and to the constant lengthening of nectar and noses." The Duke of Argyll then quotes Darwin's diffident statement "that we can thus *partially* understand how this astonishing nectary was produced," and says it is indeed but a *partial* understanding,—but he does not show what point the explanation given fails to meet. I maintain, on the contrary, that the laws of multiplication, variation, and survival of the fittest, already referred to, would under certain conditions *necessarily* lead to the production of this extraordinary nectary. Let it be remembered that what we have to account for is only the unusual length of this organ. A nectary is found in many orders of plants and is especially common in the Orchids, but in this one case only is it more than a foot long. How did this arise? We begin with the fact, proved experimentally by Mr. Darwin, that moths do visit Orchids, do thrust their spiral trunks into the nectaries, and do fertilize them by carrying the pollinia of one flower to the stigma of another. He has further explained the exact mechanism by which this is effected, and the Duke of Argyll admits the accuracy of his observations. In our British species, such as Orchis pyramidalis, it is not necessary that there should be any exact adjustment between the length of the nectary and that of the proboscis of the insect, and thus a number of insects of various sizes are found to carry away the pollinia and aid in the fertilization. In the Angræcum sesquipedale, however, it is necessary that the proboscis should be forced down into a particular part of the flower, and this would only be done by a large moth straining to drain the nectar from the bottom of the long tube.* Now let us start from the time when the nectary was only half its present length or about six inches, and was chiefly fertilized by a species of moth which appeared at the time of the plant's flowering, and whose proboscis was of the same length. Among the millions of flowers of the Angræcum produced every year some would always be shorter than the average, some longer. The former, owing to the structure of the flower, would not get fertilized, because the moths could get all the nectar without forcing their trunks down to the very base.

* It is a peculiarity of this species that the nectar only occupies a depth of one or two inches at the bottom of the nectary.

The latter would be well fertilized, and the longest would on the average be the best fertilized of all. By this process alone the average length of the nectary would annually increase, because, the short ones being sterile and the long ones having abundant offspring, exactly the same effect would be produced as if a gardener destroyed the short ones and sowed the seed of the long ones only; and this we know by experience would produce a regular increase of length, since it is this very process which has increased the size and changed the form of our cultivated fruits and flowers.

But this would lead in time to such an increased length of the nectary that many of the moths could only just reach the surface of the nectar, and only the few with exceptionally long trunks be able to suck up a considerable portion.

This would cause many moths to neglect these flowers because they could not get a satisfying supply of nectar, and if these were the only moths in the country the flowers would undoubtedly suffer and the further growth of the nectary be checked by exactly the same process which had led to its increase. But there are an immense variety of moths of various lengths of proboscis, and as the nectary became longer other and larger species would become the fertilizers, and would carry on the process till the largest moths became the sole agents. Now, if not before, the moth would also be affected, for those with the longest probosces would get most food, would be the strongest and most vigorous, would visit and fertilize the greatest number of flowers, and would leave the largest number of descendants. The flowers most completely fertilized by these moths being those which had the longest nectaries, there would in each generation be on the average an increase in the length of the nectaries, and also an average increase in the length of the proboscis of the moths, and this would be a *necessary result* from the fact that nature ever fluctuates about a mean, or that in every generation there would be flowers with longer and shorter nectaries, and moths with longer and shorter probosces than the average. No doubt there are a hundred causes that might have checked this process before it had reached the point of development at which we find it. If, for instance, the variation in the quantity of nectar had been at any stage greater than the variation in the length of the nectary, then smaller moths could have reached it and have effected the fertilization. Or if the growth of the probosces of the moths had from other causes increased quicker than that of the nectary, or if the increased length of proboscis had been injurious to them in any way, or if the species of moth with the longest proboscis had become much diminished by some enemy or other unfavourable conditions, then in any of these cases the shorter nectaried flowers which would have attracted and could have been fertilized by the smaller kinds of

moths would have had the advantage. And checks of a similar nature to these no doubt have acted in other parts of the world, and have prevented such an extraordinary development of nectary as has been produced by favourable conditions in Madagascar only and in one single species of Orchid. I may here mention that some of the large Sphinx moths of the tropics have probosces nearly as long as the nectary of Angræcum sesquipedale.* Now, instead of this beautiful self-acting adjustment, the Duke of Argyll's theory is, that the Creator of the Universe by a direct act of his Almighty power so disposed the natural forces influencing the growth of this one species of plant as to cause its nectary to increase to this enormous length, and at the same time by an equally special act determined the flow of nourishment in the organization of the moth so as to cause its proboscis to increase in exactly the same proportion, having previously so constructed the Angræcum that it could only be maintained in existence by the agency of this moth. But what proof is given or suggested that this was the mode by which the adjustment took place? None whatever, except a feeling that there is an adjustment of a delicate kind and an inability to see how known causes could have produced such an adjustment. I believe I have shown, however, that such an adjustment is not only possible but inevitable, unless at some point or other we deny the action of those simple laws which we have already admitted to be expressions of existing facts.

It is difficult to find anything like parallel cases in inorganic nature, but that of a river may perhaps illustrate the subject in some degree. Let us suppose a person totally ignorant of Modern Geology to study carefully a great River System. He finds in the lower part a deep broad channel filled to the brim, flowing slowly through a flat country and carrying out to the sea a quantity of fine sediment. Higher up it branches into a number of smaller channels flowing alternately through flat valleys and between high banks; sometimes he finds a deep rocky bed with perpendicular walls carrying the water through a chain of hills; where the stream is narrow he finds it deep, where wide shallow. Further up still he comes to a mountainous region with hundreds of streams and rivulets each with its tributary rills and gullies collecting the water from every square mile of surface, and every channel adapted

* I have carefully measured the proboscis of a specimen of *Macrosila cluentius* from South America in the collection of the British Museum, and find it to be nine inches and a quarter long! One from tropical Africa (*Macrosila morgani*) is seven inches and a half. A species having a proboscis two or three inches longer could reach the nectar in the largest flowers of *Angræcum sesquipedale*, whose nectaries vary in length from ten to fourteen inches. That such a moth exists in Madagascar may be safely predicted; and naturalists who visit that island should search for it with as much confidence as astronomers searched for the planet Neptune,—and they will be equally successful!

to the water that it has to carry. He finds that the bed of every branch and stream and rivulet has a steeper and steeper slope as it approaches its sources, and is thus enabled to carry off the water from heavy rains and to bear away the stones and pebbles and gravel that would otherwise block up its course. In every part of this system he would see exact adaptation of means to an end. He would say that this system of channels must have been designed, it answers its purpose so effectually. Nothing but a mind could have so exactly adapted the slopes of the channels, their capacity, and frequency to the nature of the soil and the quantity of the rainfall. Again, he would see special adaptation to the wants of man in broad quiet navigable rivers through fertile alluvial plains that would support a large population, while the rocky streams and mountain torrents were confined to those sterile regions suitable only for a small population of shepherds and herdsmen. He would listen with incredulity to the Geologist who assured him that the adaptation and adjustment he so admired was an inevitable result of the action of general laws. That the rains and rivers, aided by subterranean forces, had modelled the country, had formed the hills and valleys, had scooped out the river beds and levelled the plains;—and it would only be after much patient observation and study, after having watched the minute changes produced year by year and multiplying them by thousands and ten thousands, after visiting the various regions of the earth and seeing the changes everywhere going on, and the unmistakeable signs of greater changes in past times,—that he could be made to understand that the surface of the earth, however beautiful and harmonious it may appear, is strictly due in every detail to the action of forces which are demonstrably self-adjusting.

Moreover, when he had sufficiently extended his inquiries, he would find that every evil effect which he would imagine must be the result of non-adjustment does somewhere or other occur, only it is not always evil. Looking on a fertile valley he would say—"If the channel of this river was not well adjusted, if for a few miles it sloped the wrong way, the water could not escape, and all this fertile valley full of human beings would become a waste of waters." Well, there are hundreds of such cases. Every lake is a valley "wasted by water," and in some cases (as the Dead Sea) it is a positive evil, a blot upon the harmony and adaptation of the surface of the earth. Again, he might say—"If rain did not fall here, but the clouds passed over us to some other regions, this fair valley would be a desert." And there are such deserts over a large part of the earth, which abundant rains would convert into pleasant dwelling-places for man. Or he might observe some great navigable river, and reflect how easily rocks or a steeper channel in places might render it useless to man;—and a little inquiry would show

him hundreds of rivers in every part of the world which are thus rendered useless for navigation.

Exactly the same thing occurs in organic nature. We see some one wonderful case of adjustment, some unusual development of an organ, but we pass over the hundreds of cases in which that adjustment and development do not occur. No doubt when one adjustment is absent another takes its place, because no organism can continue to exist that is not adjusted to its environment; and unceasing variation with unlimited powers of multiplication, in most cases, furnish the means of self-adjustment. The world is so constituted, that by the action of general laws there is produced the greatest possible variety of surface and of climate; and by the action of laws equally general, the greatest possible variety of organisms have been produced adapted to the varied conditions of every part of the earth. The Duke of Argyll would probably himself admit that the varied surface of the earth, the plains and valleys, the hills and mountains, the deserts and volcanoes, the winds and currents, the seas and lakes and rivers, and the various climates of the earth, are all the results of general laws acting and re-acting during countless ages; and that the Creator does not appear to guide and control the action of these laws — here determining the height of a mountain, there altering the channel of a river—here making the rains more abundant, there changing the direction of a current. He would probably admit that the forces of inorganic nature are self-adjusting, and that the result necessarily fluctuates about a given mean condition (which is itself slowly changing), while within certain limits the greatest possible amount of variety is produced. If then a "contriving mind" is not necessary at every step of the process of change eternally going on in the inorganic world, why are we required to believe in the continual action of such a mind in the region of organic nature? True, the laws at work are more complex, the adjustments more delicate, the appearance of special adaptation more remarkable; but why should we measure the creative mind by our own? Why should we suppose the machine too complicated to have been designed by the Creator so complete, that it would necessarily work out harmonious results? The theory of "continual interference" is a limitation of the Creator's power. It assumes that he could not work by pure law in the organic as he has done in the inorganic world; it assumes that he could not foresee the consequences of the laws of matter and mind combined—that results would continually arise which are contrary to what is best, and that he has to change what would otherwise be the course of nature in order to produce that beauty and variety and harmony, which even we, with our limited intellects, can conceive to be the result of self-adjustment in a universe governed by unvarying law. If we could not conceive the world

of nature to be self-adjusting and capable of endless development, it would even then be an unworthy idea of a Creator to impute the incapacity of our minds to him; but when many human minds can conceive and can even trace out in detail some of the adaptations in nature as the necessary results of unvarying law, it seems strange that in the interests of religion any one should seek to prove that the System of Nature instead of being above, is far below our highest conceptions of it. I, for one, cannot believe that the world would come to chaos if left to Law alone. I cannot believe that there is in it no inherent power of developing beauty or variety, and that the direct action of the Deity is required to produce each spot or streak on every insect, each detail of structure in every one of the millions of organisms that live or have lived upon the earth. For it is impossible to draw a line. If any modifications of structure could be the result of law, why not all? If some self-adaptations could arise, why not others? If any varieties of colour, why not all the variety we see? No attempt is made to explain this except by reference to the fact that "purpose" and "contrivance" are everywhere visible, and by the illogical deduction that they could only have arisen from the direct action of some mind, because the direct action of our minds produces similar "contrivances;" but it is forgotten that adaptation, however produced, must have the appearance of design. The channel of a river looks as if made *for* the river although it is made *by* it; the fine layers and beds in a deposit of sand often look as if they had been sorted and sifted and levelled designedly; the sides and angles of a crystal exactly resemble similar forms designed by man; but we do not therefore conclude that these effects have, in each individual case, required the directing action of a creative mind, or see any difficulty in their being produced by natural Law.

Let us, however, leave this general argument for a while, and turn to another special case which our author appeals to as conclusive against Mr. Darwin's views. "Beauty" is as great a stumbling-block to the Duke of Argyll as "contrivance." He cannot conceive a system of the Universe so perfect as necessarily to develope every form of Beauty, but supposes that when anything specially beautiful occurs, it is a step beyond what that system could have produced, something which the Creator has added for his own delectation.

Speaking of the Humming Birds, the Duke of Argyll says: "In the first place, it is to be observed of the whole group that there is no connection which can be traced or conceived between the splendour of the humming birds and any function essential to their life. If there were any such connection, that splendour could not be confined, as it almost exclusively is, to only one sex. The

female birds are of course not placed at any disadvantage in the struggle for existence by their more sombre colouring." And after describing the various ornaments of these birds, he says: "Mere ornament and variety of form, and these for their own sake, is the only principle or rule with reference to which Creative Power seems to have worked in these wonderful and beautiful birds. . . . . A crest of topaz is no better in the struggle for existence than a crest of sapphire. A frill ending in spangles of the emerald is no better in the battle of life than a frill ending in spangles of the ruby. A tail is not affected for the purposes of flight, whether its marginal or its central feathers are decorated with white. . . . . Mere beauty and mere variety for their own sake, are objects which we ourselves seek when we can make the Forces of Nature subordinate to the attainment of them. There seems to be no conceivable reason why we should doubt or question that these are ends and aims also in the forms given to living organisms."*

Here the statement that "no connection can be conceived between the splendour of the humming birds and any function essential to their life;" is met by the fact that Mr. Darwin has not only conceived but has shown, both by observation and reasoning, how beauty of colour and form may have a direct influence on the most important of all the functions of life, that of reproduction. In the variations to which birds are subject, any more brilliant colour than usual would be attractive to the females, and would lead to the individuals so adorned leaving more than the average number of offspring. Experiment and observation have shown that this kind of sexual selection does actually take place, and the laws of inheritance would necessarily lead to the further development of any individual peculiarity that was attractive, and thus the splendour of the humming birds is directly connected with their very existence. It is true that "a crest of topaz may be no better than a crest of sapphire," but either of these may be much better than no crest at all; and the different conditions under which the parent form must have existed in different parts of its range, will have determined different variations of tint, either of which were advantageous. The reason why female birds are not adorned with equally brilliant plumes is sufficiently clear; they would be injurious by rendering their possessors too conspicuous during incubation. Survival of the fittest has therefore favoured the development of those dark green tints on the upper surface of so many female humming birds, which are most conducive to their protection while the important functions of hatching and rearing the young are being carried on. Keeping in mind the laws of multiplication,

* 'Reign of Law,' p. 248.

variation, and survival of the fittest which are for ever in action, these varied developments of beauty and harmonious adjustments to conditions, are not only conceivable but demonstrable results.

The Duke's argument is solely founded on the supposed analogy of the Creator's mind to ours as regards the love of Beauty for its own sake; but if this analogy is to be trusted, then there ought to be no natural objects which are disagreeable or ungraceful in our eyes. And yet it is undoubtedly the fact that there are many such. Just as surely as the Horse and Deer are beautiful and graceful, the Elephant, Rhinoceros, and Camel are the reverse. The majority of Monkeys and Apes are not beautiful; the majority of Birds have no beauty of colour; a vast number of Insects and Reptiles are positively ugly. Now, if the Creator's mind is like ours, whence this ugliness? It is useless to say "that is a mystery we cannot explain," because we have attempted to explain one-half of creation by a method that will not apply to the other half. We know that a man with the highest taste and with unlimited wealth practically does abolish all ungraceful and disagreeable forms and colours from his own domains. If the beauty of creation is to be explained by the Creator's love of beauty, we are bound to ask why he has not banished deformity from the earth, as the wealthy and enlightened man does from his estate; and if we can get no satisfactory answer, we shall do well to reject the explanation offered. Again, in the case of flowers, which are always especially referred to as the surest evidence of beauty being an end of itself in creation, the whole of the facts are never fairly met. At least half the plants in the world have not bright-coloured or beautiful flowers, and Mr. Darwin has lately arrived at the wonderful generalization that flowers have become beautiful solely to attract insects to assist in their fertilization. He adds, "I have come to this conclusion from finding it an invariable rule that when a flower is fertilized by the wind it never has a gaily-coloured corolla."* Here is a most wonderful case of beauty being *useful* when it might be least expected. But much more is proved; for when beauty is of no use to the plant it is not given. It cannot be imagined to do any harm. It is simply not necessary, and is therefore withheld! We ought surely to have been told how this fact is consistent with beauty being "an end in itself," and with the statement of its being given to natural objects "for its own sake."

Let us now consider another of the Duke's objections which he thus sets forth:—

"Mr. Darwin does not pretend to have discovered any law or rule according to which new Forms have been born from old Forms. He does not hold that outward conditions, however changed, are

* 'Origin of Species,' 4th ed., p. 239.

sufficient to account for them. . . . . His theory seems to be far better than a mere theory—to be an established scientific truth—in so far as it accounts, in part at least, for the success and establishment and spread of new Forms *when they have arisen.* But it does not even suggest the law under which, or by or according to which, such new Forms are introduced. Natural Selection can do nothing, except with the materials presented to its hands. It cannot select except among the things open to selection. . . . Strictly speaking, therefore, Mr. Darwin's theory is not a theory on the Origin of Species at all, but only a theory on the causes which lead to the relative success or failure of such new forms as may be born into the world."*

In this and many other passages in his work the Duke of Argyll sets forth his idea of Creation as a "Creation by birth," but maintains that each birth of a new form from parents differing from itself, has been produced by a special interference of the Creator in order to direct the process of development into certain channels; that each new species is in fact a "special creation," although brought into existence through the ordinary laws of reproduction. He maintains therefore that the laws of multiplication and variation cannot furnish the right kinds of materials at the right times for natural selection to work on. I believe that it can be logically proved from the six axiomatic laws before laid down, that such materials would be furnished; but I prefer to show that there are abundance of *facts* which prove the same thing.

The experience of all cultivators of plants and breeders of animals shows, that when a sufficient number of individuals are produced variations of any required kind can always be met with. On this depends the possibility of obtaining breeds, races, and fixed varieties of animals and plants, and it is found that any one form of variation may be accumulated by selection without materially affecting the other characters of the species; each *seems* to vary in the one required direction only. For example, in turnips, radishes, potatoes, and carrots, the root or tuber varies in size, colour, form, and flavour, while the foliage and flowers seem to remain almost stationary; in the cabbage and lettuce, on the contrary, the foliage can be modified into various forms and modes of growth, the root, flower, and fruit remaining little altered; in the cauliflower and brocoli the flower heads vary; in the garden pea the pod only changes. We get innumerable forms of fruit in the apple and pear, while the leaves and flowers remain undistinguishable; the same occurs in the gooseberry and garden currant. Directly however (in the very same genus) we want the flower to vary in the Ribes sanguineum, it does so, although mere cultivation for hundreds of

* 'Reign of Law,' p. 230.

years has not produced marked differences in the flowers of Ribes grossularia. When fashion demands any particular change in the form, or size, or colour of a flower, sufficient variation always occurs in the right direction, as is shown by our roses, auriculas, and geraniums; when, as recently, ornamental leaves come into fashion sufficient variation is found to meet the demand, and we have zoned pelargoniums and variegated ivy, and it is discovered that a host of our commonest shrubs and herbaceous plants have taken to vary in this direction just when we want them to do so! This rapid variation is not confined to old and well-known plants subjected for a long series of generations to cultivation, but the Sikhim Rhododendrons, the Fuchsias and Calceolarias from the Andes, and the Pelargoniums from the Cape are equally accommodating, and vary just when and where and how we require them.

Turning to animals we find equally striking examples. If we want any special quality in any animal we have only to breed it in sufficient quantities and watch carefully, and the required variety is *always* found and can be increased to almost any desired extent. In Sheep we get flesh, fat, and wool; in Cows, milk; in Horses, colour, strength, size and speed; in Poultry, we have got almost any variety of colour, curious modifications of plumage, and the capacity of perpetual egg-laying. In Pigeons we have a still more remarkable proof of the universality of variation, for it has been at one time or another the fancy of breeders to change the form of every part of these birds, and they have never found the required variations absent. The form, size, and shape of bill and feet, have been changed to such a degree as is found only in distinct genera of wild birds; the number of tail feathers has been increased, a character which is generally one of the most permanent nature and is of high importance in the classification of birds; and the size, the colour, and the habits have been also changed to a marvellous extent. In Dogs, the degree of modification and the facility with which it is effected is almost equally apparent. Look at the constant amount of variation in opposite directions that must have been going on to develope the poodle and the greyhound from the same original stock! Instincts, habits, intelligence, size, speed, form, and colour, have always varied as needed to produce the races which the wants or fancies or passions of men may have led them to desire. Whether they wanted a bull-dog to torture another animal, a greyhound to catch a hare, or a bloodhound to hunt down their oppressed fellow-creatures, the required variations have always appeared.

Now this great mass of facts, of which a mere sketch has been here given, are fully accounted for by the "Law of Variation" as laid down at the commencement of this paper. Universal variability,—small in amount but in every direction, ever fluctuating about a mean condition until made to advance in a given direction by

"selection" natural or artificial,—is the simple basis for the indefinite modification of the forms of life;—partial, unbalanced, and consequently unstable modifications being produced by man, while those developed under the unrestrained action of natural laws, are at every step self-adjusted to external conditions by the dying out of all unadjusted forms, and are therefore stable and comparatively permanent. To be consistent in his views the Duke of Argyll must maintain that every one of the variations that have rendered possible the changes produced by man, have been determined at the right time and place by the will of the Creator. Every race produced by the florist or the breeder, the dog or the pigeon fancier, the ratcatcher, the sporting man, or the slave-hunter, must have been provided for by varieties occurring when wanted, and as these variations were never withheld it would appear as if the sanction of an allwise and all-powerful Being had been given to that which the highest human minds consider to be trivial, mean, or debasing.

This appears to be a complete answer to the theory, that variation sufficient in amount to be accumulated in a given direction must be the direct act of the creative mind, but it is also sufficiently condemned by being so entirely unnecessary. The facility with which man obtains new races, depends chiefly upon the number of individuals he can procure to select from. When hundreds of florists or breeders are all aiming at the same object the work of change goes on rapidly. But a common species in nature contains a thousandfold more individuals than any domestic race, and survival of the fittest must unerringly preserve all that vary in the right direction not only in obvious characters but in minute details, not only in external but in internal organs; so that if the materials are sufficient for the needs of man, there can be no want of them to fulfil the grand purpose of keeping up a supply of modified organisms exactly adapted to the changed conditions that are always occurring in the inorganic world.

Having now, I believe, fairly answered the chief objections of the Duke of Argyll, I proceed to notice one or two of those adduced in an able and argumentative essay on the "Origin of Species" in the July number of the 'North British Review.' The writer first attempts to prove that there are strict limits to variation. When we begin to select variations in any one direction, the process is comparatively rapid, but after a considerable amount of change has been effected it becomes slower and slower till at length its limits are reached, and no care in breeding and selection can produce any further advance. The race-horse is chosen as an example. It is admitted that, with any ordinary lot of horses to begin with, careful selection would in a few years make a great improvement, and in a comparatively short time the standard of our best racers might be reached. But that standard has

not for many years been materially raised, although unlimited wealth and energy are expended in the attempt. This is held to prove that there are definite limits to variation in any special direction, and that we have no reason to suppose that mere time, and the selective process being carried on by natural law, could make any material difference. But the writer does not perceive that this argument fails to meet the real question, which is, not whether indefinite and unlimited change in any or all directions is possible, but whether such differences as do occur in nature could have been produced by the accumulation of variations by selection. In the matter of speed a limit of a definite kind as regards land animals does exist in nature. All the swiftest animals —deer, antelopes, hares, foxes, lions, leopards, horses, zebras, and many others, have reached very nearly the same degree of speed. Although the swiftest of each must have been for ages preserved, and the slowest must have perished, we have no reason to believe there is any advance of speed. The possible limits under existing conditions, and perhaps under possible terrestrial conditions, has been long ago reached. In cases, however, where this limit had not been so nearly reached as in the horse, we have been enabled to make a more marked advance and to produce a greater difference of form. The wild dog is an animal that hunts much in company, and trusts more to endurance than to speed. Man has produced the greyhound, which differs much more from the wolf or the dingo than the racer does from the wild Arabian.

Again, it is objected that the Pouter or the Fan-tail pigeon cannot be further developed in the same direction. Variation seems to have reached its limits in these birds. But so it has in nature. The Fan-tail has not only more tail feathers than any of the three hundred and forty existing species of pigeons, but more than any of the eight thousand known species of birds. There is, of course, some limit to the number of feathers of which a tail useful for flight can consist, and in the Fan-tail we have probably reached that limit. Many birds have the œsophagus or the skin of the neck more or less dilatable, but in no known bird is it so dilatable as in the Pouter pigeon. Here again the possible limit, compatible with a healthy existence, has probably been reached. In like manner the differences in the size and form of the beak in the various breeds of the domestic Pigeon, is greater than that between the extreme forms of beak in the various genera and subfamilies of the whole Pigeon tribe. From these facts, and many others of the same nature, we may fairly infer, that if rigid selection were applied to any organ, we could in a comparatively short time produce a much greater amount of change than that which occurs between species and species in a state of nature, since the differences which we do produce are often comparable with those which exist

between distinct genera or distinct families. The facts adduced by the writer of this article, of the definite limits to variability in certain directions in domesticated animals, are no objection whatever to the view that all the modifications which exist in nature have been produced by the accumulation by natural selection of small and useful variations, since those very modifications have equally definite and very similar limits.

To another of this writer's objections — that by Professor Thomson's calculations the sun can only have existed in a solid state 500 millions of years, and that therefore *time* would not suffice for the slow process of development of all living organisms — it is hardly necessary to reply, as it cannot be seriously contended, either that this calculation has any claims to even approximate accuracy, or that the process of change and development may not have been sufficiently rapid to have occurred within that period. His objection to the Classification argument is, however, more plausible. The uncertainty of opinion among Naturalists as to which are species and which varieties, is one of Mr. Darwin's very strong arguments that these two names cannot belong to things quite distinct in nature and origin. The Reviewer says that this argument is of no weight, because the works of man present exactly the same phenomena, and he instances patent inventions, and the excessive difficulty of determining whether they are new or old. I accept the analogy, and maintain that it is all in favour of Mr. Darwin's views. For are not all inventions of the same kind directly affiliated to a common ancestor. Are not improved Steam Engines or Clocks the lineal descendants of some existing Steam Engine or Clock? Is there ever a new Creation in Art or Science any more than in Nature? Did ever patentee absolutely originate any complete and entire invention, no portion of which was derived from anything that had been made or described before? It is therefore clear that the difficulty of distinguishing the various classes of inventions which claim to be new is of the same nature as the difficulty of distinguishing varieties and species, because neither are absolute new creations, but both are alike descendants of pre-existing forms, from which and from each other they differ by varying and often imperceptible degrees. It appears then, that however plausible this writer's objections may seem, whenever he descends from generalities to any specific statement, his supposed difficulties turn out to be in reality strongly confirmatory of Mr. Darwin's view.

I cannot conclude this paper without expressing my admiration of the manner in which many subjects are treated in the "Reign of Law." With the definition and limitation of the term "Supernatural," I cordially agree. The exposition of the mechanism of flight is in every respect admirable; and the views on the Political

and Social aspects of the Free Labour question are calculated to do much good, and to draw attention to a subject of the highest importance. The want of equal success in treating the question of the Origin of Species, is no doubt due to the excessively varied and complex nature of the phenomena presented by organized beings. Fully to grasp what is involved in that question demands a knowledge of details, which it requires years of study to amass; and without such knowledge the acutest and most comprehensive intellect will not suffice to solve so intricate a problem.

II. INTERNATIONAL EXHIBITIONS.

By Fred. Chas. Danvers, M.S.E.

At the close of another grand International Exhibition we may well pause for a while and consider how far these great displays of the works of industry have fulfilled the objects for which they were first established. The thirteenth Paris Industrial Exhibition, and the second International collection of works of art and industry which has been held in that city, is now within a few days of its termination; and we may, therefore, for all practical purposes, speak of it as a thing of the past. Whatever articles of exhibition it may have contained that were considered especially deserving of remark have long since been reported on, and the Exhibitors have been awarded such prizes as the respective juries have thought fit to recommend. The building will yet remain open for a short time longer, and then the work of removal and demolition will speedily commence.

Before making any special allusion to the Paris Exhibition, it is our present intention to take a hasty glance at the origin and growth of Exhibitions generally, and the measures which preceded the first International Exhibition. We are indebted for much of our information on this subject to a Report on the Paris Exhibition, drawn up for the Society of Arts by M. Digby Wyatt, Esq., in 1849; and, with reference to Exhibitions in England, to the Official Catalogue of the International Exhibition of London, published in 1862.

Industrial Exhibitions in their early youth may have been content with a pedlar's pack, the travelling show-van, or a booth at a fair; but as soon as they gave up their gipsy life they began as national displays. It was long before the growing free-trade spirit of the age allowed them to become international, although museums did occasionally dabble in the products of foreign industry, and a catalogue of curiosities exhibited at the public theatre of Leyden, in 1699, gives an amusing account of one of these early Exhibitions.

THE FOUR GREAT INTERNATIONAL EXHIBITIONS

XUM

THE FOUR GREAT INTERNATIONAL EXHIBITIONS

LONDON 1851. ——— AREA 18½ ACRES

PARIS 1855. ——— AREA 23¾ ACRES.

LONDON. 1862 ——— AREA 24½ ACRES.

PARIS. 1867. ——— AREA 35 ACRES.

Scale.

F. C. Danvers, del^e

M. R. N. Hanhart, lith

In the fifth year of the French Republic (1797) the Marquis d'Avéze was requested by the Minister of the Interior to undertake the office of Commissioner to the Manufactures of the Gobelins (tapestries), of Sèvres (china), and of the Savonnerie (carpets). On visiting those establishments the marquis found the workshops deserted; for the artisans had been in a starving condition for two years, while the warehouses were full of the results of their labours. It then occurred to him that if these and other objects of industry could be collected together into one large Exhibition, a stimulus might be given to the native industry, and thus relief be afforded to the suffering workmen. This plan was approved by the Minister of the Interior, and the chateau of St. Cloud was appropriated to the purpose. Before the day fixed for public admission a number of distinguished persons in Paris and many foreigners visited the Exhibition, and made purchases sufficient to afford some temporary relief to the necessities of the workmen. On the morning of the day fixed for the opening, however, the walls of the city were placarded with the decree of the Directory for the expulsion of the nobility; the chateau of St. Cloud was given into the custody of a company of dragoons, the Marquis d'Avéze was in the proscribed list, and thus ended the scheme which had begun with so much promise. Early in the following year, however, on his return from proscription to Paris, the marquis resumed his labours. The place selected for the Exposition was the Maison d'Orsay, Rue de Varennes, No. 667; and it proved so attractive and successful that the Government determined to adopt the idea and to carry it out on a grand scale. An admirable opportunity was afforded on the return of Napoleon from the successful termination of the Italian wars; and on the same spot in the Champ de Mars on which the army had celebrated the inauguration of Italian spoils, and only six weeks after that fête, the nation erected the "Temple of Industry," around which were arranged sixty porticoes filled with objects of use or beauty. The Exhibition remained open only during the last three complementary days of the sixth year of the Republic: but it excited the greatest enthusiasm throughout the country. The merits of the several Exhibitors, who numbered 110 in all, were entrusted to the decision of a jury composed of nine men, distinguished in science and in art; and this plan was found to work so well that it was continued in subsequent Expositions, the only change being an increase in the number of the jurors.

The success of this Exposition was so complete that the Executive determined in future to have an Exposition every year, which should include also the provinces. Accordingly they addressed letters to the préfets of departments, requesting them to form committees whose office it should be to determine what local products were

worthy of being forwarded to Paris at the public expense, and of becoming eligible to compete for a prize either of 20 silver medals, offered by the Government, or of one gold medal to be awarded to anyone who should have opposed the most formidable rivalry to British manufacture.

Although it had been decided to have annual Expositions, there was nevertheless an interval of three years between the first and the second official Exposition, which latter took place in the quadrangle of the Louvre, in 1801, under elegant porticoes erected for the occasion. Two hundred and twenty nine Exhibitors were admitted to the competition. Seven who had already obtained gold medals were set aside, and the eight best manufacturers placed in the second order in 1798 were separated from the list, in order to reserve the silver medals for their equals in industry; and hence arose the custom of voting only confirmation of previous rewards in favour of those who honourably maintained their already acquired position. It was on this occasion that Jacquard obtained a bronze medal, and subsequently an annuity of 1,000 francs, which was ultimately increased to 6,000 francs.

The next Exposition was held on the same spot in the following year, and in it the number of Exhibitors had again doubled, amounting to 540. The Exposition had by this time lost its exclusive and aristocratic character: articles in common demand were largely exhibited, and among the striking features of the collection were the extended application of mechanical and chemical science to facilitate production, and consequently to reduce the price of articles in popular demand. Twenty-two gold medals were distributed for such inventions or improvements as the hydraulic-ram of Montgolfier, the stocking-frame of Aubert; the silk-spinning machine of Vaucanson, and the chemical products of Decroisilles of Rouen, and Amfry and Darcet of Paris. One of the immediate results of the extended popularity of these Expositions was the establishment of the 'Société d'Encouragement,' which afterwards greatly assisted in developing the inventive genius of France, and in the application of abstract science to the wants and requirements of manufactures. This was followed by the fourth Exposition, in 1806, in which appeared for the first time the printed cottons of Mulhausen and Logelbach. The manufacture of iron by the aid of coke instead of charcoal, and that of steel by an improved process, and the application of the power of transferring ornaments from copper-plates to the surface of porcelain, were amongst the improvements which there marked the progress of manufactures.

An interval of thirteen years took place between the fourth and the fifth Expositions. The leading feature in the fifth Exposition was the improvement in the art of metallurgy; the great iron-works of the Loire contributed excellent castings, whilst the forges

of Grossouvre (department of Cher) sent specimens of rolled iron. Four years after this the sixth Exposition, held in 1823, marked the progress which had been made in the application of the improved manufacture of iron to machinery and construction, and the consequent development of Civil Engineering as a profession. A model of the first French Suspension Bridge, designed by Messrs. Séguin, intended to cross the Rhone between Tain and Tournon, was there exhibited. After another interval of four years, the seventh Exposition was opened on 1st August, 1827. The collection exhibited showed the influence which steam, as a motive power, was beginning to exert on manufactures, both by improving their quality, and cheapening the cost of their production.

The eighth Exposition was opened in the Place de la Concorde, on 1st May, 1834. Among the chief novelties exhibited there may be mentioned paper-hangings printed from cylinders, by Zuber, of Mulhausen; the revival of the arts of enamel and niello by Wagner; the formation of elastic tissues by means of india-rubber; the revival of the art of wood-engraving, and the attempt to rival the excellence of Boule and Riessner in marqueterie and inlaid work.

The ninth Exposition, held in 1839, illustrated the steady development of success in manufactures in the production of vast quantities of goods at the lowest prices, a practice which had not previously found much favour in France. Five years after this the tenth Exposition was opened on 1st May, 1844, and it is said to have been the most successful of the series, and to have illustrated in the most decided manner the influence of long-continued peace on the industry and productive powers of France. On that occasion the first specimens of Daguerreotype were exhibited. Altogether no fewer than 3,960 manufacturers exhibited, of whom 3,253 were more or less honourably recognized by the jury.

After an interval of five years came the eleventh Exposition, which was opened in the Champs Elysées on 4th June, 1849. Since the former Exposition the empire of Louis Philippe had been swept away, and a republic raised upon its ruins; arrangements were, however, made for giving it an air of greater magnificence than any which had preceded it. The area of the building (exclusive of an enormous agricultural shed) was equal to about 5 acres 2½ rods; the number of exhibitors amounted to 4,494, and that of the central jury to 64. In this Exposition live stock and agricultural produce were, for the first time, admitted to compete for prizes. It is worthy of remark that previous to this Exposition the idea was proposed, and rejected, to invite other nations to contribute, in order that the French might be made acquainted with the skill of those nations with which they so often come into competition in foreign markets. The building erected for the purposes of this

Exposition was placed on the Carré de Marigny, a large oblong piece of ground abutting on the main avenue of the Champs Elysées. The architect was M. Moreau. The whole plot covered a parallelogram of about 675 by 328 feet English, round the outline of which was a gallery about 90 feet wide, divided into two avenues by a double range of pilasters.

In England, the Society of Arts may claim the credit of having originated national exhibitions. In 1756, about the period when the Royal Academy first began its Fine Art Exhibitions, that Society offered prizes for improvements in the manufacture of tapestry, carpets, porcelain, and other things, and exhibited the articles which were offered for competition. It also offered prizes for improvements in agricultural and other machines, and, in 1761, a gentleman was paid to attend an exhibition of machinery in the Society's rooms, and to explain the models exhibited. The progress of national exhibitions in England was not by any means so marked and steady as in France. Such industrial displays had to fight their way against a vast amount of apathy and prejudice. The first project set on foot for commencing an annual public exhibition of this kind was coldly received, and even denounced by the mouth-pieces of public opinion. This Exhibition, however, was formed in 1828, under the patronage of King George IV., on the plan which had been found successful in France, the Netherlands, and the United States; and the King's Mews at Charing Cross, which stood on the site of Trafalgar Square and was pulled down in 1833, was fitted up to receive the few productions sent in for exhibition. The Exhibition was opened on Monday, June 23rd, 1828, and was described by the following title:—"The National Repository for the Exhibition of Specimens of New and Improved Productions of the Artizans and Manufacturers of the United Kingdom, Royal Mews, Charing Cross." This National Repository met with a most decided opposition from the public, but it succeeded in struggling through some four Exhibitions of decreasing merit; and when it left the King's Mews, in 1833, it still carried on a languishing business for a short time at a room in Leicester Square.

During this time the Society of Arts had continued to give their attention to the subject. In 1829 the Secretary of the Society read papers on several of the leading industries of the country, and from that date specimens of raw materials, manufactures, and new inventions were frequently collected in the old rooms in the Adelphi. Then followed local Trade Exhibitions, held at Manchester, Birmingham, Leeds, Dublin, and other places; and the Exhibition of Manufactures at the Free Trade Bazaar, held in Covent Garden Theatre in 1845. In that year the Society of Arts tried to revive the idea of forming periodical Exhibitions of Industrial products in England on the plan of the French Expositions.

A committee was appointed for the purpose, and a fund subscribed to meet the preliminary expenses; but owing to the want of sympathy on the part of the manufacturers the project was not then proceeded with. On the late Prince Consort becoming President of the Society, he advised the encouragement of the application of the Fine Arts to our manufactures. A special prize fund was accordingly established, and premiums and medals were offered for the production of manufactured articles of simple form. The first competitive designs were to be sent in to the Society on or before the 15th May, 1846, and the articles rewarded with prizes in that year, together with those sent in for competition in 1847, formed the basis of the first Exhibition of "Select Specimens of British Manufacture and Decorative Art," which was opened at the house of the Society of Arts in March, 1847. Very few competitors came forward in 1846, and the Exhibition of 1847 would have been a total failure but for two individuals, who made it a point of personal favour with a few great manufacturers to be permitted to select from their stores a sufficient number of articles to make a show. The result was highly satisfactory. Twenty thousand people visited the Exhibition, and the Council arranged a third display, which was opened in March, 1848. This time the contributions from manufacturers were sent in unsolicited, and even forced upon the Society, and upwards of seventy thousand persons visited the Society's rooms. The Society's Exhibition of manufactures in 1848 was followed by an Exhibition of pure art, known as the "Mulready Exhibition." In June of the same year, and at the opening of the Society's session in November, 1848, its first exhibition of models of machinery was announced to take place in January, 1849. In the spring of 1848 the third general "Exhibition of Recent Specimens of British Manufactures and Decorative Art" was held at the old house in the Adelphi, and this Exhibition was closely followed by a second art display, known as the "Etty Exhibition," which took place in the same rooms in June, 1849.

In the year 1849 an Exhibition of Manufactures and Art, in connection with the meeting of the British Association for the Advancement of Science, was held at Birmingham with very encouraging results; and the success of the French Exposition, held during the same year, coming as it did just as the country had embarked on its career of partial free-trade, gave a fresh impulse to the idea of holding a great National Exhibition of British Industry. The promoters of the scheme at that time contemplated only a national exhibition, and they asked for pecuniary aid from Government to enable them to carry it out.

Many have advanced claims, since 1851, to be considered the originators of the proposition for holding universal or international Exhibitions. M. Boucher de Perthes, President of the 'Société

Royale d'Emulation of Abbeville,' boldly recommended the holding of an 'Exposition Universelle' in the year 1834, in an address which he then delivered to the Society. The Prince Consort was the first to take the Society of Arts' plan for an enlarged national display in hand, and to mould it into an universal exhibition; and, at a meeting held at Buckingham Palace, on the 29th June, 1849, he suggested the four great divisions of Raw Material—Machinery and Mechanical Inventions—Manufactures—and Sculpture and Plastic Art, of which he proposed the Great Exhibition should consist. In July of the same year a general outline of a plan of operations was drawn up, and after they had become more matured, meetings were held in fifty towns; and by January, 1850, the names of sixty thousand influential persons had been obtained as supporters of the great plan. At a banquet at the Mansion House, in May, 1850, the Prince Consort stated that the proposed collection and exhibition in one building of the works of industry of all nations was "to give a true test and a living picture of the point of development at which the whole of mankind had arrived in this great task, and a new starting point from which all nations will be able to direct their further exertions."

Upon the presentation of reports prepared under the direction of the Society of Arts, a Royal Commission was issued, in January, 1850, in order to carry out all the necessary details of arrangement for accomplishing the great object in view. The ultimate result was the establishment of the Exhibition in Hyde Park, in the year 1851. The design for the building—which still exists in the Crystal Palace at Sydenham—was made by the late Sir Joseph Paxton, and its erection was entrusted, under contract, to Messrs. Fox and Henderson. The Exhibition was opened on 1st May and closed on 15th October 1851. After settling all claims, the Commissioners found themselves in possession of surplus funds amounting to 213,305*l.* 15*s.* 8*d.*, which was subsequently invested in the "Gore House Estate," and other property at South Kensington.

The great financial and general success of the Exhibition of 1851 naturally encouraged the repetition of such displays all over the world. There was the Cork Exhibition in 1852; two were started simultaneously in 1853, one in New York, and the other in Dublin, both of which were universal exhibitions. The Munich Exhibition came next, in 1854; this display was not international in the broadest sense, but the whole of Germany was allowed to take part in the competition. The twelfth Exhibition in Paris followed this in 1855, which was the first great French International Exhibition. It imitated very closely the plan of 1851. The exhibitors, although showing a decrease upon those of 1851 in London, showed a marked increase upon those of the eleventh French Exposition in 1849; and the building in which it was held

still exists in the Champs Elysées, and is known by the name of the Palais de l'Industrie. After this great international display came the Manchester Fine Art Exhibition in 1857; the Dublin Art Exhibition, the Edinburgh Art Treasures Exhibition, and the Italian National Exhibition at Florence, all in the year 1861; the second great London Exhibition in 1862; and the second International Exhibition in Dublin in 1865. Since the last London Exhibition of 1862 there have also been International Agricultural Exhibitions held at Aarhaus in Denmark, and at Vienna; an International Cheese Exhibition near Paris; Fishery Exhibitions at Christiania, Archangel, and Boulogne, and the grand International Flower Show, which took place last year in the Horticultnral Gardens at South Kensington; and finally, the Paris Exhibition of the present year.

Nothing could well be imagined more unsightly, or devoid of architectural pretensions, than the building erected for the purpose of the present Paris Exhibition; the Emperor himself has compared it to a huge gasometer, and perhaps no better idea of its unsightliness could well have been suggested. All outward appearance has indeed been sacrificed for the purpose of obtaining convenience of classification, and, at first sight the plan adopted appears to possess some merits, but in practice it has been found that the classification is not only unscientific but unjust. The Duke of Marlborough, in a memorandum read to the British jurors on the 20th April last, called their attention to the difficulties arising out of the system adopted whereby, as he stated, "objects are locally placed in one class which possess elements for the consideration of several juries." The very use of juries in international exhibitions has indeed began to be seriously discussed; and, in the same memorandum to which we have just referred, it was suggested that "as furnishing materials for a future report it would be desirable, while the subject is fresh, to note down the opinions of the many eminent gentlemen employed as to the working of the international juries generally, the mode of procedure they have found it desirable to adopt in their several cases, the success that has attended it, and the opinion that the jurors have formed from the experience of this Exhibition of the utility of juries at all International Exhibitions."

In the plate which accompanies this article we have given a front elevation, drawn to scale, of the four great International Exhibitions of London and Paris. The buildings of the three earlier Exhibitions have already been repeatedly described, and we shall, therefore, not further allude to them in the present article, but pass on to give a hasty description of the Paris Exhibition of 1867.

This building, standing in the centre of the Champs de Mars, is in the form of two semicircles connected together by parallel

sides, and the entire structure may be said to consist of a series of concentric rings arranged around a central garden. In the middle of this garden is a small circular domed building, containing a collection of all the standard weights and measures of different countries; and at the boundary of this garden, and inside the inner circle of the Exhibition building, is a covered piazza which formed a favourite lounge for visitors. Around the inner circle are arranged, concentrically, a series of galleries, or arcades, of varying dimensions, intersected radially by sixteen avenues leading from the outer to the inner circles, and a second covered piazza runs round the outside ring of the building. All the inner galleries are lighted from the roof, but the covering of the outside gallery, which rises to a height considerably above the rest of the building, is unpierced, light being furnished to it by a row of clerestory windows on either side surrounding the entire building at an elevation above the roofs of the adjoining galleries. The inner galleries which contain the Fine Arts court, and the History of Works Museum are built of solid masonry, with roofs of iron and glass of no great span. The intermediate galleries consist of light trussed wrought-iron roofs, supported on hollow cast-iron columns, and on the apex of each roof is a skylight, by which the gallery below is lighted. This portion of the building in no way enters into composition with the articles exhibited, and, with the exception of the roof, it may, for all practical purposes of effect, be said to have disappeared. The great exterior circle, or nave, is 110 feet wide and nearly 82 feet high in the centre; the pillars supporting it, of which there are 86 pairs, are each 83 feet 6 inches in height, and 62 feet 10 inches to the springing of the arched roof. In this gallery machinery was principally exhibited, and in its centre a raised platform, supported on cast-iron columns, extends right round the building in an unbroken line, excepting where it is intersected by the grand avenue, from either side of which it is approached by a flight of steps. The columns supporting this promenade served also to carry the shafting by means of which motion was communicated to the machinery.

This great zone has an outside diameter of about 1,550 feet lengthways, and 1,250 feet across, and contains an area of upwards of 11 acres, whilst the entire Exhibition building, with the central garden, occupies a space of about 35 acres. It would be impossible, however, to state the actual area of the space occupied for the purposes of exhibition, for all the surrounding park, having an area of about 70 acres, is studded all over with annexes and other buildings erected by the many exhibitors who could not obtain space within the main building. Besides the general annexes there have been erected in this park lighthouses, theatres, a club, churches, various manufactories for glass-blowing and cutting, baking, washing, &c. &c.,

model cottages, restaurants, besides houses for pumping and blowing engines, boilers, &c., connected with the ventilation, steam and water supplies to the Exhibition generally. In one corner of the park, which has been railed off, a *jardin réservé* was formed, in which exhibitions of fruits, flowers, and vegetables were periodically held; and one interesting part of this garden was the establishment of two huge aquariums, for salt and fresh water fish respectively.

It has already been stated that the building is arranged in a series of annular galleries, and each of these devoted to the exhibition of a certain class of objects; thus, the innermost circle contained a collection illustrative of the History of Labour from the earliest known period. Gallery No. I. contained Works of Art, including paintings, sculptures, &c.; No. II. Apparatus and application of the Liberal Arts; No. III. Furniture, and other articles for the use of dwellings; No. IV. Clothing, and other articles of wearing apparel; No. V. Raw and Manufactured Products; and No. VI. Machinery, including instruments and processes employed in the useful Arts. Outside of the machinery gallery a smaller court was devoted to the exhibition of Articles of Food in different degrees of preparation, where also were restaurants of all nations, in which trial might be made of all the Continental, English, American, and Oriental styles of preparing and serving up food.

In order the better to show such various agricultural operations as could not be carried on within the limits of the Champ de Mars, an Exhibition was organized on the Island of Billancourt, where competitions and trials of agricultural machines took place for the purpose of enabling the juries to make their awards. And an exhibition of live stock was likewise held fortnightly at the same place.

The total number of exhibitors was upwards of 42,000, showing a considerable increase on any previous Exhibition. Thus, in 1851 the number of exhibitors was under 14,000; in 1855 there were 24,000, and in 1862 the number did not quite come up to 29,000.

The Exhibition illustrative of the History of Art was certainly a novel feature, but it contained articles more stictly adapted for a museum than for an Industrial Exhibition. In this respect it was somewhat out of place, and, irrespective of the interesting nature of its contents, its introduction possessed no charm to recommend it beyond that of novelty.

The collection of pictures could not for one moment compare with that of 1862, since they were all to have been produced within the last 12 years, and consequently the works of ancient masters were necessarily excluded. England could make but little show, since the best examples of her paintings admissible under the rules are private property. The French collection was large rather than

choice; and perhaps the best collection altogether was that from Belgium, the chief portion of which was contained in a separate building erected in the park. In statuary the French and Italians were almost without competition, scarcely anything of this class having been sent from England, and it will be sufficient here to state that the richest treasures from the museums of each of the former countries were to be found in the Exhibition.

Photography, hardly known in 1851, occupied no small space within the building. The positions obtained by salts of silver, or by the carbon process, have recently been much improved; and the productions of enamels, one of the most interesting applications of Photography, has made great progress; but one of the chief improvements is that of the heliographic process, by which Photography may be converted into processes of printing by means of ink, either on metal or on stone. Although a positive and satisfactory mode of fixing photographic pictures in their natural colours on paper has not yet been invented, coloured pictures have been obtained on paper, when, until last year, they could only be produced on metal.

A very general improvement was noticeable in furniture and decoration; but with the exception of one or two individual pieces of furniture, the merits of different countries have been more evenly balanced in this than in any other branch of labour. The principal improvements are due, to a great extent, to the employment by manufacturers of distinguished artists, whose co-operation has introduced art and good taste into the manufacture.

In porcelain the French and English are almost the only large manufacturers. And although the French claim the first place, they themselves admit to great improvements in the manufacture of Faïence from the introduction of the methods employed in England. The substitution of coal for wood in the baking of porcelain in France has led to a reduction in its price, and great improvements have been introduced into the art of decoration through the cromolithographic process. The French, and indeed nearly all the continental porcelain, is of the *pâte dure* variety, whilst the English alone manufacture the famous *pâte tendre* sort. The colours also of some of the English porcelain may truly be said to have been unsurpassed in the Exhibition. In clear cut-glass the English remain unsurpassed, and in imitations of the Venetian and Bohemian, the products of England compare, not unfavourably, with specimens of manufacture from those countries.

In Telegraphy there has been a good deal of quiet progress going on since 1862. In Submarine Telegraphy more has been achieved since 1862 than in all the years that preceded it; and in consequence of the experience thus gained, engineers have, almost without exception, discarded cables completely iron-sheathed, and

are adopting the last Atlantic model, consisting of a few iron or steel wires embedded in hemp.

In no former Exhibition has there been so good a collection of raw and manufactured produce; but the specimens were often so widely scattered that it became a task of no little difficulty to make fair comparisons. Great attention was given to mining and mining apparatus, especially by France, and her collection of Civil Engineering models was one of the most interesting parts of the whole Exhibition.

Since 1862 France and Belgium have wonderfully improved in the manufacture of iron and steel, so that this country is not now so far ahead in its iron manufacture as was formerly the case. Foreigners now, also, make more of their own tools and machinery than heretofore; and although their best specimens are generally copies from English models, they can now, for all practical purposes, turn out in many places as good machinery as could be obtained in this country; in excellency of design, however, and in finish, there is still no country that has come up to the standard of English manufactures. Alarmists have raised the cry that England is not keeping pace with the advancements of other countries, but we are disposed rather to believe the truth to be that whilst we steadily advance, other countries, which a few years since were much behind us, have made themselves acquainted with all that we possess, and thus are able to make more rapid strides, and to lessen the distance between us and themselves.

It has been, undoubtedly, principally through the instrumentality of International Exhibitions that other countries have made themselves acquainted with our arts, and we have learned theirs; and thus the diffusion of knowledge throughout the world has been hastened and extended. The rapid growth of these Institutions may at length be said to have reached a fair limit, and although the first International Exhibition resulted in a large pecuniary surplus, subsequent ones have not, in most cases, even succeeded in paying their expenses, and it stands to reason that the larger the Exhibition, the more expensive it must be, and consequently the less likely to prove remunerative. For the future, then, it may be anticipated that International Exhibitions will not be so general as heretofore, but will rather be confined to one class of objects, by which means it will be possible to hold them in some permanent building for which a rent only would be paid, and thus the chief expense which now attends their promotion will be obviated.

III. ON THE LUMINOSITY OF THE SEA.

By Cuthbert Collingwood, M.A., M.B., F.L.S.

During my recent expeditions as Naturalist on board H.M.S. 'Serpent,' one of the subjects to which I was anxious to pay especial attention was the luminosity exhibited by the sea, its appearance and various forms, the various conditions under which it became manifest, and, as far as possible, the causes which produced it. These points have already engaged the attention of observers, but much remains yet to be learned, nor shall I profess to add a great deal to what is already known, but shall simply relate the result of my observations carried on at every opportunity during a year and a half. Not a night passed while I was at sea without my looking out for luminous appearances—jotting down anything novel or unusual, and where practicable, making an examination for the detection of the cause of the luminous appearance;—and although the moonlight nights were very beautiful, I often bewailed the invisibility of the luminous animals whose light was extinguished by the effulgence of the moon's rays, and longed for a return of the dark nights when the brilliancy of the stars compensated for the absence of the moon, without putting a stop to my observations on the luminosity of the sea.

I would classify all the cases of luminosity which have come under my observation under the following five heads:—

1. Sparks or points of light.
2. A soft, liquid, phosphorescent effulgence.
3. Moon-shaped patches of steady light.
4. Instantaneous recurrent flashes.
5. Milky sea.

The first of these, or the appearance of points or sparks of light, is by far the most common, and in different degrees may be said to be all but universal. Whether the other forms of luminosity are exhibited or not, sparks of light in greater or less abundance are scarcely ever absent. The sea, more particularly when agitated, sparkles with brilliant points of light, varying in size from that of a pin's head to that of a pea—and of greater or lesser permanency—some being almost instantly extinguished, while others retain their light for an appreciable time. I do not think I ever looked at the sea on a dark night without seeing some few sparks, even though I might enter a remark that the sea was "*not* luminous to-night." But usually these sparks are abundant, and on occasions they present a wonderfully brilliant appearance. On one occasion, when this phenomenon was unusually striking, on the coast of China in lat. 26° N., on drawing up bottles full of water and pouring it out in the dark, the water sparkled brightly as luminous points ran

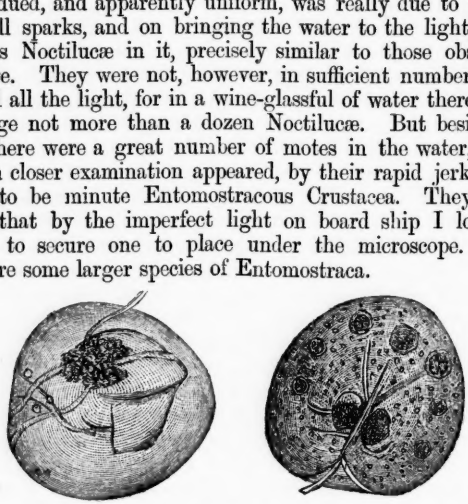
over, but a close inspection revealed nothing in the water but a few minute entomostraca. On another occasion when some water which had been left in a basin exhibited luminosity at night, I got a very brilliant spark upon my finger, and taking it to the light, it proved to be a minute crustacean.

The second form of luminosity to be noticed occurs comparatively rarely. It consists of a soft, usually greenish light, which only makes its appearance when smooth water is disturbed, and is only seen in calm weather. This form appears identical with what we see nearer home, as on the shores of Ostend and in the estuary of the Mersey. This form of luminosity I have observed on only three occasions, and under similar circumstances, and I have reason to believe that the cause is the same on all occasions, whether in the Eastern seas or in the Mersey. On the 5th of July being on the coast of China, in lat. 27°, the weather in the afternoon became dead calm, and after sunset I remarked that the sea was beautifully luminous, but altogether without conspicuous sparks or points of light. Wherever the ripples caused by the advancing ship rolled away, they were crested with bright green light, and the ship's hull appeared to be enveloped in a luminous sheath. On this occasion the effect did not last long, and I did not examine the water microscopically.

The next time I noticed this form of luminosity was in Singapore harbour, on November 6th. The wind was east, thermometer 76°, weather fine. The water was like glass, smooth and beautiful, but exhibited no light except when disturbed; but every oar-stroke of the boat in which I rowed produced eddying circles of light, and a lovely soft green glow crowned every ripple from the bows. A splash in the water produced a shower of a myriad minute sparks, the aggregate of which made up this delicate luminosity, which I never saw so beautifully exhibited as upon this night. The following night the same effect was visible, but scarcely so intense as before (wind N.E., temp. 76°), and on the third night (the wind being E. and temp. 75°), I again observed it. After this I was absent from Singapore two nights, and on my return I no longer noticed the luminous effect.

On each of these three nights, I examined the water;— as I filled a bottle, bright sparks of light adhered to my hands, and on bringing it to the light I found that it contained a number of small globular greenish bodies, which floated upon the surface for the most part, but appeared to have the power of freely moving in the water. On closer examination these bodies proved to be *Noctilucæ;* and during the night I observed that the contents of the bottle frequently flashed with bright and rapid coruscations. I had no difficulty therefore in coming to the conclusion that the peculiar luminosity in the harbour was due to the presence of innumerable *Noctilucæ*.

On the 24th of May, lying in Simon's Bay, Cape of Good Hope, the water was similarly luminous. The weather was fine, wind W.N.W. light, bar. 30·04, thermom. 60°. On examining the water closely I found that, as before, the luminous effect, though soft, subdued, and apparently uniform, was really due to innumerable small sparks, and on bringing the water to the light, I found numerous Noctilucæ in it, precisely similar to those observed at Singapore. They were not, however, in sufficient numbers to have produced all the light, for in a wine-glassful of water there were on an average not more than a dozen Noctilucæ. But besides these bodies, there were a great number of motes in the water, many of which on closer examination appeared, by their rapid jerking locomotion, to be minute Entomostracous Crustacea. They were so minute, that by the imperfect light on board ship I long tried, in vain, to secure one to place under the microscope. Besides these were some larger species of Entomostraca.



Noctilucæ.

The Noctilucæ measured from $\frac{1}{275}$ to $\frac{1}{325}$ of an inch in diameter; they were of a pale greenish colour when seen with the naked eye, closely resembling Volvox in appearance, but with a much less active movement. They had, however, powers of locomotion, though the means were not apparent under the microscope. They had a dark nucleus, usually irregular, but in some cases spherical and well defined. Their circumferential outline was very faint, and their general aspect very variable. A kind of slit appeared to extend through two-thirds of the body, from which faint lines radiated, usually having a double outline, and not reaching the circumference of the sphere, but often terminating in large round granular bodies of various sizes. The whole body was studded with oil globules of various sizes, which strongly refracted the light; but slight movements, which appeared to be taking place in an almost imperceptible manner, soon changed the whole aspect of any individual Noctiluca while under observation, so that the description or drawing of one minute did not answer for the next. Each Noctiluca had a large curved cilium projecting beyond the body, and apparently taking its rise from the nucleus. This form of luminosity, although very

striking, appears to be completely extinguished by moonlight, even when the moon is young. It appeared, only less marked, on the two following evenings, and on the third we left the bay. I am informed that Simon's Bay has been remarked as frequently exhibiting this phenomenon.

On the 7th of July, in lat. 28° N., on the coast of China, two days after the occurrence of this form of luminosity, as before noticed, a heavy swell coming in from the S.W. was met by a N.E. wind, and the ship rolled tremendously. The sea was beautifully luminous, every wave breaking into a pale light which was visible at a considerable distance, so that the whole sea was streaked with light, and again that peculiar phenomenon of the ship sailing in a luminous sheath was visible. The night was very dark, and it was lightning vividly and incessantly; the whole scene was eery and weird in the extreme. I mention this case because it was one of the most striking instances of general luminosity which has come under my notice; it appeared to be compounded of the two forms I have already described.

The third form of luminosity to be described consists of moon-shaped patches of steady white light, which I have found to be a very common phenomenon under certain circumstances. Next to the occurrence of sparks and always accompanied by them, this form of luminosity is most frequently seen, and does not appear to be confined to any particular locality. I first observed it in the Mediterranean, on the first night on which the absence of the moon allowed it to be visible, and I have since found it to be no less frequent in the Red Sea, the Indian Ocean, the China Sea, and the Atlantic, north and south of the equator. It is most commonly visible in the wake of the ship, and consists of numerous round patches of light, which might be mistaken for white-hot shot of various sizes beneath the water at different depths. Sometimes, when deep down, they were pale and of a whitish colour, with indistinct outline, and of large size, but when nearer the surface they were smaller and more distinct, and assumed a pale greenish tinge. They usually remained visible for 8 or 10 seconds, but sometimes less. As these appearances were just such as might be presented by the umbrellas of large Medusæ, were such present and luminous, I was strongly inclined at first to attribute them to this cause; and the fact that on one occasion (about a week after I left England) I saw these moonlight patches in the Red Sea on the evening of a day on which the ship had passed through a shoal of Aureliæ, led me to attribute them to this cause. I supposed that the Aureliæ, struck by the screw, gave out their light under the excitation of the blow, and floated away luminous and dying. But I was forced to abandon this theory afterwards, for I have since many times watched for floating Medusæ before the light failed, and not seen

one for days and weeks together, and yet the moon-shaped patches have been as bright and as abundant as before; and again, when we have passed through a thick shoal of Medusæ towards evening, the luminous appearances have not been more marked than usual, but even less so. Moreover, having secured one of these Acalephs, it has not exhibited any luminosity during the night.

Although, however, I ceased to regard the Acalephæ as the source of the luminous appearances in question, there can be no doubt that the great numbers which are always visible immediately under the stern are due to the fact of the eddies of the ship exciting the emission of light in certain animals capable of exhibiting luminosity. Not however that similar appearances are never seen in other situations where they are unmolested, though I must say that in my experience this is rare. Thus in the Indian ocean, in lat. 12½° N. and long. 55° E. (bar. 30°, them. 82°), among other appearances I noticed now and then a large patch of light with a roundish irregular outline pass by, emitting a pale and steady light, although out of the path of the ship; and on August 17th, being in a small boat on the coast of Borneo in a strong breeze after dark, I observed deep beneath the surface and entirely apart from any influence of the oars, the appearance of large globes of white light, shining persistently and spontaneously.

Although I long and constantly watched for the bodies which produced this remarkable and frequent luminous effect, I did so for a long time in vain. In vain I attempted to penetrate below the surface in search of any animals which could possibly originate the light. Although I could distinctly see the bottom of the ship's rudder, 19 feet deep, I could never detect a trace of any living thing within that depth by day, but no sooner did darkness supervene than they were often in abundance. It was only by accident, on June the 2nd, in lat. 28½° S., and long. 9° E., that I was witness of a circumstance which seemed to elucidate the question. Looking as usual over the stern, there were plenty of moon-shaped patches, accompanied by sparks unusually large and bright. The patches were remarkably persistent, and could be traced for nearly half a minute after the ship had passed. They were evidently a considerable but varying distance below the surface of the water; when far down they appeared large and faint and ill defined, but when nearer the surface they were smaller, brighter, and better defined. As I watched, one of the bright bodies whirled about by the eddy of the rudder came absolutely to the surface and exhibited a nearly rectangular form of great brilliancy, of a pale green colour, and as far as I could judge about six inches long by two broad. It at once occurred to me that it was a Pyrosoma, and that this Ascidian was the usual cause of the phenomenon, the circular form of the patches being produced by the diffusion of the

light through a depth of water. I continued watching for a long time in hopes of seeing another, but although so good an opportunity did not occur again, many seemed to come near the surface, diminishing in size, but increasing in brilliancy as they did so; one particularly low down, suddenly gave out a dazzling brilliancy, producing a momentary effulgence all around.

I may mention that on a moonlight night when the moon has been dimmed by fleecy clouds, I have been able to see the moonlight patches, but when the moon shone out clearly they were no longer visible.

I have now to describe the fourth form of luminosity exhibited by marine animals, *viz.* momentary recurrent flashes of light. This form is nearly as commonly seen as the moon-shaped patches already described, which it very frequently, although perhaps not always, accompanies. If, however, the latter are well marked, the flashes are almost sure to be visible. I first observed them in the Indian ocean, north of the line, and since then, in the China seas and Atlantic. This appearance is very striking, but can only be seen under favourable circumstances, *i. e.* when the night is dark and the sea smooth. An indistinct transitory patch of light appears in the water, as evanescent as a flash of lightning; so rapidly does it come and go that it is difficult to fix the exact spot where it occurred. The brightness of the flash varies probably according to the depth of the animal producing it below the surface; sometimes it is of considerable brilliancy, and sometimes so pale that it would not have been noticed but for its suddenness. The colour is always whitish, and the form of the flash round, brightest in the middle, and becoming indistinct at the circumference. I have on some occasions seen these flashes occur in such numbers and with such rapidity that it would be impossible to count them, though more commonly they are comparatively few and far between.

But the fact which interested me most in these flashes of light was that they always occurred at a distance from the path of the ship. Although I have seen them accompanying the moon-shaped patches of light in the ship's wake, the places from which I could best observe the flashes were the forecastle or the gangways, when they could be seen in the smooth water several yards distant from the ship's side, and entirely uninterfered with by the ship's motion. This fact proved to me that there were spontaneous emissions of light by some animals below the surface, which voluntarily and at intervals gave out a bright coruscation. Moreover, although rarely, on following with the eye the spot where the flash appeared, it could be seen to reappear further astern, as though the emission was recurrent at definite intervals, as is the case with the luminous beetles called fire-flies at Singapore. I have also noticed on more than one occasion that the flash, instead of instantly disappearing,

was followed by a faint glow which vanished gradually, but whether this was an optical illusion of the retina or not, I cannot be sure.

Whatever may be the animals which produce these luminous appearances, they must habitually swim at a considerable depth. I never was able to make out any definite outline of the light, which always appeared more or less spherical with faint edges, and sometimes the size and faintness of the flashes seemed to prove that the light must have been diffused by its passage through a great depth of water, which would also account for the whitish appearance of what is probably really greenish light. But I am strongly disposed to believe that the sources of the flashes and of the moon-shaped patches are identical; in the one case emitting their light spontaneously, and in the other, under the excitation of the eddies produced by the ship, and especially by the screw-propeller when at work.

Before quitting the subject of these flashes, I must not omit to mention that while at Singapore, having taken some small Medusæ in a towing-net in the Straits, I placed them in a glass which stood by my bedside. In the night I observed them flashing brightly with instantaneous flashes, of the same character as those above referred to, although not the slightest shaking was applied to the bottle, or irritation to the animals. So also the Noctilucæ of Singapore harbour, which I kept similarly in a bottle, flashed frequently with rapid and bright coruscations; and I am strongly disposed to believe that luminous marine animals in health, and acting spontaneously, without external irritation, always exhibit their luminosity in this manner, and that it is only when strong excitation is applied that they give out a steady but temporary glow.

There remains but one form of luminosity to be noticed, which although I have never been so fortunate as to witness it myself, has been observed by others, who have been longer at sea than I. This is what has been called *milky sea*, an extraordinary phenomenon of rare occurrence. It has been described to me as a general luminous glow, not confined to the crests of ripples or to disturbed water, but occurring in perfectly calm weather, and looking as though the whole sea was composed of a whitish fluid like milk, with no bright spots or sparks. Such an appearance reflecting a faint light upwards illuminates the ship, rendering every part of the rigging plainly visible, and inasmuch as it can only be seen in the absence of the moon, the contrast of the white glowing sea with the black sky produces an effect calculated to strike the observer with a kind of awe. Although I have met with persons who tell me they have not unfrequently seen this phenomenon, I am disposed to believe that it is extremely rare. One who has not really seen it at all might erroneously suppose, that such an appearance as I

have already alluded to as having twice occurred to me on the coast of China (when the ship seemed to be sailing in a luminous sheath) corresponded to the description of a milky sea, and in a small way it did so, and I considered it, at the time, as the nearest approach to it I had ever observed. But the milky sea must be something *sui generis*, and I imagine it to be owing rather to a condition of the water under certain peculiar atmospheric or climatic influences than to any extraordinary number of luminous animals in the water. A circumstance which occurred to me seemed to throw some light upon the subject and confirmed me in this opinion. Having put down the towing-net in the Formosa Channel it collected a number of small entomostraca, megalopas, minute medusæ, small porpitæ, pteropods, annelids, globigerinæ, &c., which I placed in a basin of sea water, and not having finished my examination of them they remained upon the table during the night. On stirring the water in the dark the whole became faintly luminous, giving out a general glow as if every particle were phosphorescent, the minute crustacea, &c., appearing as bright spots in the luminous fluid. If the slimy substance, in which in some marine animals at least the luminous property appears to reside, become diffused through the water, as it is probable it may be under certain combinations of conditions and circumstances, a general luminosity of the water may result, similar to that observed in milky sea, while its small sparks, doubtless in great abundance, would remain unnoticed in the universal glow, but would at the same time greatly enhance the general luminous effect.

There is a common idea that a southerly wind is peculiarly productive of luminosity in the sea, but according to my observations this is an error. The winds most prevalent when luminosity has been well marked have been westerly, north-westerly, or even easterly, south being perhaps the least frequent; but probably the direction of the wind has no special influence in the matter. What the favourable conditions really are it is as difficult to say as it is in the case of floating animals generally. I have seen remarkable exhibitions on one night followed by nearly absolute darkness on the next, the conditions of wind, weather, barometer and thermometer, being inappreciably altered. Probably temperature is as important as any influence; the luminosity in the Mersey only occurs in summer, and in rounding the Cape of Good Hope during the winter season, scarcely any luminosity was exhibited during the month that we were passing through the higher degrees of S. latitute.

The animals which I have observed to possess luminous properties are not numerous. Many of the more minute animals taken in the towing-net appear to exhibit them, more particularly the small Crustacea (Entomostraca) and small Medusæ (Medusidæ),

I have no reason to believe that the large Medusæ (Lucernaridæ) as Aurelia, Pelagia, Rhizostoma, &c., exhibit any luminous powers, having kept specimens which have invariably failed to do so. Nor do I believe that the Physophoridæ are luminous. I have never seen a luminous Porpita or Velella; and although on one occasion, when magnificent specimens of Portuguese men-of-war had been floating by all day, my attention was directed to shining spots at night, under the supposition that they were luminous Physaliæ, I merely replied by pointing to a bucket containing one of these animals, but which was perfectly dark. I have seen a large prawn give out light after death, and a fresh squid was illuminated at night with an irregular glow of whitish light, which remained unaltered as I passed my finger over the surface. Nor do I believe the stories of luminous fish, inasmuch as fish rapidly swimming in a fluid abounding in minute luminous points, as the sea sometimes does, would present an effect which an uninformed or inaccurate observer would readily mistake as proceeding from the fish itself, instead of from luminous points which it disturbed in its passage.

IV. OUR FIELD CLUBS: THEIR AIMS, OBJECTS, AND WORK.

1. *Transactions of the Woolhope Naturalists' Field Club (established* 1851), *including the first part of the Flora of Herefordshire.* By the Rev. W. H. Purchas, L.Th., 1866.
2. *The President's Address and Reports for* 1866, *together with the Rules, List of Members, and Catalogue of Books of the West Kent Natural History, Microscopical, and Photographic Society.*
3. *The Proceedings of the Cotteswold Naturalists' Field Club for* 1865.
4. *Proceedings of the Bath Natural History and Antiquarian Club.*
5. *Report of the Liverpool Naturalists' Field Club for the year* 1866.
6. *Proceedings of the Bristol Naturalists' Society.* Edited by Wm. Lant Carpenter, B.A., B.Sc.

Naturalists' Field Clubs, compared with other societies devoted to scientific pursuits, are institutions belonging to a very recent period: the oldest of them, in this country, has not yet celebrated its jubilee, and few have existed so long as ten years; yet now no season passes without adding to the already numerous list.

XUM

The inquiry, "What are the objects of Naturalists' Field Clubs," may best be answered in the words of some of their most zealous promoters.

Sir Wm. Jardine, Bart., President of the Dumfriesshire and Galloway Natural History and Antiquarian Society, thus states the object of the Society:—"To secure a more frequent interchange of thought and opinion among those who cultivate Natural History and Antiquities; to elicit and diffuse a taste for such studies where it is yet unformed; and to afford means and opportunities for promoting it."

G. S. Brady, Esq., Secretary of the Tyneside Club, says:—"The objects of Naturalists' Field Clubs may be said to be twofold. First, the study of nature out of doors, and (as being inseparably connected with this) the collection of specimens for more minute examination at home. Secondly, the preservation of natural objects from wanton useless destruction."

The Rev. Leonard Jenyns, President of the Bath Natural History and Antiquarian Field Club, says:—"There are two especial objects which a Club such as ours has, or ought to have, in view. One is the thorough investigation of the neighbourhood in which it carries on its researches as regards its Natural History and Antiquities; the other, the bringing together men of the same pursuits, with the addition of those who, without following up any particular branch of science themselves, may yet enjoy the society of those who do, or who may like to join the Club for the sake of its excursions, the health and exercise they afford, and the pleasure of rambling over new ground."

Leo. Grindon, Esq., Secretary of the Manchester Field Naturalists' Society, says:—"The great aim of the Society is to call forth and encourage latent taste for Natural History."

We are inclined to agree with the most liberal of these opinions, and to think that too much solicitude is sometimes shown by the managers of Field Clubs, to secure that no meeting should be without a prominent share of speech making or paper reading. No doubt the members of any voluntary association have a right to make their own arrangements, but if the Field Club be the agency to which we must look for the wide diffusion of a taste for Natural History, the excursion programme should in every case be drawn up with due consideration for the predilections of incipient naturalists.

We remember attending Professor Sedgwick's lectures at Cambridge, over thirty years ago: the class-room was not always crowded, but on the occasions when the accomplished Professor took the field, mounted on his well-known black steed, there was ever a goodly attendance of equestrian pupils at the meet; and if at the close of his ride, taken at a dashing pace right across the country, there were fewer students present at the concluding lecture, the falling

off of his audience certainly did not arise from any mere geological deficiencies. It is said that some who joined the Professor's class, chiefly for the fun of the mounted excursion, afterwards became eminent as geologists.

It is, however, manifest that the successful working of a Field Club must depend on the suitability of its plans to the circumstances of its position. Field Clubs commonly belong to one or the other of two distinct classes. 1st. Such as occupy a wide field extending over a large portion of a county, and include amongst their members chiefly professional men, and men of independent position. 2ndly. Such as are established in populous towns.

To the former of these divisions belongs the Cotteswold Naturalists' Field Club, of which we need only say that the intellectual and genial character of its gatherings is such as to induce men of eminence in science, even when residing in London, frequently to attend its meetings. Its publications have not been issued regularly, but are of the highest scientific value.

The Woolhope Naturalists' Field Club has this year issued a volume of transactions, which plainly indicates the Club to be in a thriving and vigorous condition. The speciality of the work, however, mainly consists in that portion of it which contains the Flora of Herefordshire, edited by the Rev. W. H. Purchas. The Flora is accompanied by a map of the county divided into fourteen botanical districts: a schedule follows, pointing out the plants found in each district. The editor modestly disclaims originality in adopting this plan; but we do not know that it has been carried out with the same degree of completeness in any other county. The difficulty of obtaining satisfactory reports from so many districts must have been very great.

We quote from the advertisement:—"It has of late years been felt that a very imperfect view of the botany of any county was given by the plan on which the older Floras were drawn up; that plan being to mention stations for the rarer plants, or those supposed to be such, whilst it was left to be inferred that the remainder were equally common throughout the whole area to which the Flora related. The real truth being that species which, from their frequency in one part of a county, might be expected to prevail equally throughout its whole extent, are found, when specially sought after, to be comparatively local."

Whilst Field Clubs very rightly devote a good deal of attention to the geographical distribution of plants, it may be remarked that the geographical distribution of the Field Clubs themselves is a subject worthy of notice. A map of England marked with the stations of these Clubs would show them to be very unequally distributed. A belt extending from Lancashire along the western side of England to the south coast would include amongst others

the following: Bath, Bristol, The Caradoc, The Cotteswold, Cheltenham, Dudley, Exeter, Liverpool, Malvern, Manchester, Oswestry, Preston (1867), Severn Valley, Somersetshire, The Teign, Worcestershire, and The Woolhope. In the rest of England the stations marked would be comparatively few and far between. Are we to apply to the geologists or the ethnologists for an explanation of this?

The list of Herefordshire plants is a large one: some of the districts, particularly that of Ross, have been fortunate in possessing a representative not afraid to attack such formidable botanical problems as the Willows and the Brambles. A list of plants, however, even if it were perfect, would convey but little instruction unless connected with information respecting the physical and geological features of the district to which it belonged. This want has been supplied by the Rev. W. S. Symonds, President of the Malvern Club, who has given an admirable account of the local and geological characters of each of the fourteen subdivisions of the county. It is announced that a future portion of the Flora will consist of a "more detailed mention of the different plants, and will give any further information that may seem needful."

The volume contains full reports of the excursions, referring to which Dr. Bull, the President, in his retiring address, remarks, "The published reports of our field days make people wish they had been with us." Not the least doubt of it! Who would not wish to share in such *dies ambrosianæ*, with salmon and the goodly haunch of venison on the board, and such men as Bentham (of the Handbook) and Brodie and Symonds as guests, besides the members of the Club, around it?

Before leaving the Woolhope proceedings we must refer to the series of photographs of remarkable trees in Herefordshire: these are not the only indications that this Club gives more than common attention to the subject of trees, too often almost neglected by botanists.

The Bristol Naturalists' Society differs from most others in having distinct sections for entomology, chemistry and photography, zoology, botany, and geology. A general meeting is held once in the month; the sections also have monthly meetings and excursions, and contribute funds to the library of the Society.

The Liverpool Naturalists' Field Club professedly aims at the extension of a taste for natural science, and seems to have ample scope for its efforts amongst its 720 members. Some peculiarities in its plan are thus noticed by the President:—"As the plan of giving prizes (books on natural history subjects) originated with our own Club, I may state that practically it has been found very successful. Many younger members of the Club, beginning with the prizes (at the excursions) most easily attainable, have been

encouraged to proceed zealously with studies which otherwise would not have been entered upon; whilst some of the collections sent in for our annual prizes have far surpassed all our expectations." "Large numbers join our excursions who are not particularly interested in any branch of natural science, and this is just what the chief object of our Club renders a desirable circumstance. The busy appearance of our workers, who often come when tea is half over, flushed with exercise and animated with success, is a suggestive lesson to others who may be found waiting at the door of our meeting room half-an-hour or even an hour before the appointed time; a lesson on the difference of the amount of pleasure afforded by a walk with a special object, and a walk without one." "Our numerical strength gives to our most valued members facilities for visiting localities at great distances, on terms which could not otherwise be obtained. We are able to engage a special train and make a journey of 160 miles in a day, at a cost, including a substantial dinner-tea, of about seven shillings each, allowing five hours for work at the locality visited."

Naturalists' Societies now in operation in Great Britain have upon their lists probably not fewer than 4,000 members: we may safely add an equal number to represent professors, students, collectors, and others not connected with any society, yet more or less actively engaged in the same pursuit, Such a company should be able to give a good account of the natural history of their own country, yet many interesting branches have been all but wholly neglected, and some are at present without even a moderately useful *Handbook*, *e. g.* The Fresh-water Algæ, the Annelids, and the Centipedes: but even in the pursuits which are most popular, much remains to be done. Members of Naturalists' Societies must be aware that a question is pending which in Zoology and Botany may open a field for investigation, comparatively, as vast as that annexed to astronomy by the invention of the telescope. Yet it is a marvel how few direct their efforts towards the acquisition of evidence for or against the hypothesis of the origin of species by natural selection. Facts well authenticated and chosen with discrimination on either side are equally and, at present, pre-eminently, the desiderata of natural science.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The Cattle Plague has not yet entirely left us. During the past quarter several cases have occurred on farms lying eastward of London, to which the infection may have been brought by the imported stock which is landed at Thames Haven and taken into the Metropolitan Market by a railway passing through the district which has suffered. And thus it is, in all probability, that the disease has at length reached the farm and large herd of cows near Barking, belonging to the Metropolitan Sewage Company, to whose proceedings reference has more than once been made in this Chronicle. There were 238 cows on this farm early in August, feeding on the sewage-grown grass which is there cultivated. Of these 12 became diseased and were killed and buried, and 115 were condemned to be slaughtered as having been infected by contact with diseased animals. There then remained 111, in two sheds detached from the homestead, and these have remained healthy. They had been fed on the same food as the others, and being surrounded by the meadows irrigated by the sewage water, were not only thereby more easily and completely isolated from the other stock, but were at the same time more liable to any injurious influence which the sewage may be capable of exerting. It is satisfactory to learn from this experience, that neither on the food nor on the treatment of these cows can the losses by the Cattle Plague be charged, that sewage-grown grass is perfectly wholesome food, and that the Cattle Plague is, as it has always been supposed to be, simply the result of an imported poison, the special produce of the disease itself. Of the quantity as well as quality of the produce which sewage-water raises even on poor land, the experience of the Barking farm is satisfactorily conclusive. Flax, mangold-wurzel, potatoes, cabbages, and grass have been grown luxuriantly on it; and dressings of the young wheat-plant in spring and early summer have shown what immense bulk of straw can be thus ensured—from which, in suitable seasons, no doubt increased yield of grain must follow. Of the Italian ryegrass thus produced a record has been kept, and on many acres upwards of 50 tons per acre had been obtained from five cuttings by the middle of August. It seems certain that the produce of sewage applications, under all ordinary circumstances, must be sufficient to return a satisfactory profit after the deduction of expenses.

Professor Anderson has lately delivered at Glasgow an interesting lecture on recent laboratory results, in which he called attention to the state of the guano trade, the superphosphate manufacture, the quality of oil cakes, and of drinking water—all of them important agricultural subjects. He informs us that the guano on some of the Chincha islands is already exhausted, and that recent imports are of inferior quality—containing considerably more water and considerably less ammonia than the qualities which have hitherto been common—a difference capable of correction only by the artificial addition of at least 20 shillings-worth of sulphate of ammonia to the ton—"and to this extent the price of the guano is practically enhanced by this diminution of its quality." Of recently manufactured superphosphates Professor Anderson reports an improvement. They are indeed no longer manufactured from bones, but the process by which the mineral phosphates are converted is more completely carried out, and new supplies, of excellent quality, are from time to time discovered. Thus it has been lately met with in nests in a particular kind of dolomite in the valley of the Lahn, a tributary of the Rhine. The mines of Staffel yielded last year 2,500 tons of a quality containing 55 to 65 per cent. of phosphates. It is here in a new and unexpected geological formation, and there can be little doubt that by an extended search many similar deposits will be found.

During the past year Professor Anderson has found bran, grass seeds, carob beans, French nutcake, and other adulterations in oil-cakes of British manufacture. And we are informed of the offer in the market of inferior mixtures containing mustard and other small seed, with the avowed purpose of "reducing high quality linseed." A dealer in cakes, we are told, has sold at 11*l.* a ton an article, which he stated was of the highest quality, under the name of the "Simon Pure." It was found on analysis to contain bran, and since then he has supplied his customers with the *real* Simon Pure at 11*l.* 10*s.*, "so that in commerce as well as in comedy there are a real and counterfeit Simon Pure."* Professor Anderson touched lastly on the character of the drinking water given to cattle. He has lately examined the water from wells on several farms, and has found them to contain nitrates obviously derived from the infiltration of animal matters. The presence of such matters is injurious to human beings, and is in all probability also mischievous to the live stock of the farm.

One of the more remarkable features of the annual show of the

* For the guidance of analysts and of our agricultural readers, we may mention that the following substances are used for the adulteration of linseed cake: wheat-bran, ground rice-husks, inferior rape-cake, inferior groundnut-cake, Niger cake, damaged cotton cake, cake made from damaged linseed, Dodder cake, Sessame cake, Indian corn meal, locust beans, &c.; but the worst, and most valueless substance used is ground rice-husks, known as "shudes."

English Agricultural Society at Bury last July, was the illustration given of the economical application of steam-power to light-land cultivation. By means of two engines, one at either end of the cultivated field, two tools are worked at once; and when the widest tools were used—Fowler drags a 13-tine cultivator which takes a width of 4 yards at once—the cultivation was accomplished at the rate of 50 acres in a day. It seems plain that on light-land farms as well as clays, wherever the area has been properly laid out for steam cultivation there need in future be no more horse-power provided and kept throughout the year than will suffice for the harvesting and marketing of the crops; in fact, for all the work of carriage. With Fowler's or with Howard's double engines, each with double drum working two tools simultaneously, there is no reason why a square of 20 acres, or even more of land which had been ploughed by steam-power before winter, should not be grubbed or cultivated, and receive a thorough harrowing all at once in a single day in spring, or why a thorough fallowing after a winter's frost upon the autumn tillage of stiff clays should not be thus accomplished almost at a blow.

The hot and variable weather, accompanied by thunderstorms, of the current season has been greatly against the dead-meat trade; and some easy preservative of quality is under such circumstances greatly needed. Messrs. Medlock and Bailey have patented the use of their solution of bisulphite of lime for this purpose. Two quarts of this solution, one pint of common salt, and four gallons of water, constitute the wash, by which it is said that a joint of meat may be preserved fresh in the hottest weather. A dip night and morning into such a mixture will keep meat sweet for any length of time; and when afterwards dipped in cold water for a few minutes and then dried thoroughly with a cloth it is ready for cooking, unaltered in any detectable way from the day it was slaughtered. Such are the assertions of the patentees; and they are sufficiently striking to deserve examination.

The weather of the past spring and summer has proved on the whole better for succulent growth than for the formation and ripening of seed, and the reports of the grain harvest are not satisfactory. More than half the reports of the wheat crop supplied to the 'Agricultural Gazette' declare it to be under average, and that is a larger proportion than was similarly returned last year, when the crop was undoubtedly an inferior one. The crops of spring-sown oats and barley, and especially of beans, are believed, on the other hand, to be generally good.

2. ARCHÆOLOGY AND ETHNOLOGY.

YIELDING to the desire of the Belgian Minister of the Interior, M. Dupont has collected into a small octavo volume the first series of his papers on the Belgian caverns, under the title of "Notices préliminaires sur les fouilles exécutées sous les auspices du gouvernement Belge dans les cavernes de la Belgique." It contains notices of the caverns on the banks of the Lesse explored up to the month of April, 1866; of the caverns on the banks of the Meuse explored up to October, 1865; and of the author's researches into the Quaternary deposits of the valleys of both those rivers. These memoirs having been originally published in the Bulletin of the Academy of Sciences of Brussels are now tolerably well known, and require no further notice at our hands; but their publication in a compact form will be welcome news to the many English ethnologists and geologists who are interested in the progress of M. Dupont's researches.

Mr. J. S. Moore has recorded, in the Journal of the Royal Geological Society of Ireland, the finding of a stone hatchet, under interesting circumstances, at Kilbride, County of Wicklow. It was found imbedded in hard clay, and carefully covered by a large stone, fourteen inches broad, eighteen inches deep, and two feet long, perfectly flat on the under side, and weighing about 3 cwt. This stone was firmly imbedded, and wedged in by five other large stones, varying in weight from one to three hundredweight. About two loads of smaller stones were firmly and closely packed upon these. Stiff hard clay rose around the base of the large stones to the height of six inches, and from that up to the surface of the ground lay about 18 inches of bog. The author speculates on the means—natural and artificial,—whereby the hatchet may have been placed in the position in which it was found, and the most probable of his suggestions seems to be that it was hidden there by a native previous to the growth of the bog, and the accumulation of the clay around the base of the large stones.

A controversy on the subject of certain submarine forests on the shores of Liverpool Bay and the River Mersey has been carried on for some time past between the Rev. Dr. A. Hume and Mr. Joseph Boult. The latter gentleman in several papers, and especially in one recently published in the 'Transactions of the Historic Society of Lancashire and Cheshire,'* upholds the idea that the peat of this district has been derived from other localities where peat pre-existed, *e. g.* Chat Moss, and that the remains (Roman) found in it "are appurtenant to the original localities from which the peat is derived, and may furnish a clue to identify those localites wherever they

* New series, vol. vi., p. 89.

may be." Dr. Hume in the same publication (p. 1) advocates the belief that the forests and peat are the result of growth *in situ*, and that in some cases there are successive beds of forest-remains separated by strata deposited by water. The Roman remains found near Great Meols he considers the proof of a Roman settlement; and the evidences of encroachments of the sea show that the land has been submerged since the growth of the forest. Mr. Boult's opinions being diametrically opposed to these, the two authors have brought together all the evidence they could obtain, and have thus produced two papers of considerable interest to local archæologists and historians.

In the 'Comptes Rendus,' * M. Guérin has recorded the finding of a core and some flakes of *obsidian* in the neighbourhood of Lunéville, the material being the curious element in the discovery. For some time this remained an isolated fact, but the perseverance of M. Guérin has since been rewarded by his detecting near Aingeray—a small commune in the Department of the Meurthe,—some fragments of a vase remarkable for its shape and material; and very near it a chipped flake consisting of a vitreous substance. On putting together the fragments of the vase, M. Guérin recognized the shape to be the same as that of some found in accumulations of the Bronze-age in Alsace.

Sign. Gualterio has recorded† the discovery of a fossil human cranium in the Quaternary travertin of Viterbo, associated with bones of Ox, Goat, and a species of *Emys*. No opinion as to its more precise age is hazarded by Sign. Gualterio, but the probability is that it belongs to a very recent period, possibly within historic times.

The Archæological Institute, the British Archæological Association, and the Cambrian Archæological Association have held their annual meetings during the past quarter at Hull, Ludlow, and Hereford, respectively. Several churches, castles, and other buildings were visited; but little was done in reference to the Prehistoric period. We must mention, however, that a large tumulus, supposed to belong to the Roman period, was opened at Thruxton, near Hereford, during the meeting of the Cambrian Association.

In our last Chronicle we described some of the ancient inscriptions (Oghamic, Runic, &c.) of Ireland and Scandinavia, and we have now to record the publication of Mr. John Stuart's work, entitled 'The Sculptured Stones of Scotland,' in two volumes, illustrated by more than 200 plates. Our space will not allow us to describe the contents of this work; but we may mention that the sculptures include representations of men and animals, symbolical figures, and Pictish, Runic, and other inscriptions.

Two numbers of the 'Anthropological Review' (Nos. 18 and 19,

* Vol. lxv., No. 3 (July 15, 1867), p. 116.
† Atti della Società Italiana di Scienze Naturali, vol. viii., fasc. 4, p. 285.

for July and October), have been published during the past quarter. Their contents are for the most part remarkably speculative and general, rather than descriptive, which latter, in the youth of a science, we venture to think they ought to be. We shall therefore select only a few papers more especially worthy of notice.

Mr. Carter Blake's paper "On the Human Jaw from the Belgian Bone-caves," is here published in full; but as we discussed the abstract of it in our last, we need do no more here than record the fact.

Mr. E. B. Tylor has a paper "On the Phenomena of the Higher Civilization traceable to a rudimental Origin in Savage Tribes," in which he attempts to show that certain customs still practised in civilized communities are traceable to a barbarous origin. For instance, "The astrology of Zadkiel's Almanac does not appear to me to differ from the old rules; the ordeal of the key and Bible is very old and widely spread; country people still make a heart and run pins into it to hurt the heart of some person with whom they choose to associate it, as any savage might do." All that Mr. Tylor writes is worth reading, and this paper is not an exception, for in many instances he shows how curious customs still extant amongst the superstitious crowd of a country fair have got their origin. But we take the liberty of asking, Can these exhibitions of superstition be dignified with the title of "the phenomena of the *Higher* Civilization?" Ought the author not to have said, rather, the Lower Civilization? It seems, however, that the term "savage" is sufficiently distinctive from "civilization" to render the use of any comparative adjective unnecessary. But Mr. Tylor may possibly regard the savage condition as a rudimentary stage of civilization, and has some name more glittering than civilization for the habits, customs, and modes of thought of the educated people of the present generation.

Dr. J. Thurnam has a paper in support of his theory that long skulls are found in long barrows, and short skulls in short barrows; but he qualifies it by admitting that while he considers the first part of his proposition to be strictly true, the second he concedes is subject to exceptions, and that the round skull is simply the *prevailing* type found in the round barrow. We cannot enter into the details of measurements, &c., by which the theory is supported, but for them must refer our readers to the paper, which is entitled "Further Researches and Observations on the two principal Forms of Ancient British Skulls." We may also mention that Mr. C. Carter Blake, in the next paper, "On certain Skulls from Round Barrows in Dorsetshire," endeavours to show that no such distinctions exist; but we have seen that Dr. Thurnam himself states that the "round barrows, round skulls" is not an absolutely rigid proposition.

Dr. Thurnam also endeavours to draw a distinction as to the relative ages of the two forms of barrows, and states that no well authenticated instance of the finding of metal, or of the finer decorated pottery, with the primary interments in long barrows was known to him; but only objects of stone, bone, or horn, and a peculiar coarse kind of pottery. In the round barrows, on the contrary, "objects of bronze (very rarely of iron) and richly decorated pottery are often found, with or without objects of stone." The author therefore referred the long barrows to the Stone-age and the round ones to the Bronze-age, and the period of transition from that to the Iron-age.

In a paper "On the Natives of Madagascar," Mr. Thomas Wilkinson shows the existence in that island of two distinct races of men—one inhabiting the sea-coast and the other the interior of the island. "The former have woolly hair, brown or black skins, strong white teeth, and in fact all the characteristics of a superior order of Negroes. Within the last few years this race has been conquered by the people inhabiting the interior of the island, who are called *Hovas*, and are generally slender, often small, with, in many cases, long, straggling, unsound, and ugly teeth, straight coarse hair, and light-brown skins, with faces resembling those of the Chinese or of other Mongolian races."

In a paper entitled "On Physio-Anthropology, its Aim and Method," Dr. Hunt endeavours to divide his science into two portions, namely "Physio-Anthropology," or the doctrine of the functions of mankind, and "Physical Anthropology," or the doctrine of the forms of mankind; just as in Zoology and Botany we have the divisions of Morphology and Physiology. Still, from the tenour of the paper, this comparison, which is instituted by Dr. Hunt himself, does not seem to be quite parallel, otherwise Physio-Anthropology is simply Human Physiology. What then is this new department of the science of man? Dr. Hunt says, "By physio-anthropology I mean, not the philosophy of the human mind, but the science of the functions of mankind;" and he further illustrates his meaning and rescues it from obscurity by remarking, "I have quoted from Mr. Spencer chiefly to show that the term I have employed, . . . differs in no essential respect from what that writer understands by human psychology generally." Apart from this subject, Dr. Hunt's paper is a resumé of opinions on the subject of Psychology, such as the question whether the size of the brain has any direct relation to intellectual power and capacity; the doctrines of phrenology; and many other kindred subjects of considerable interest, which are, we presume, the chief portions of Physio-Anthropology. It should be mentioned that Dr. Hunt partially justifies his classification and division of Anthropology by the action of the British Association last year. It is therefore un-

fortunate for his argument, that they have this year returned to their original classification of the sciences.

3. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

THE question whether any change has really taken place in the lunar crater Linné still divides astronomers. Many distinguished observers have expressed the opinion that Linné continues unaltered. Mr. De la Rue considers that photographs of the moon taken before and since the period of Schmidt's supposed discovery, exhibit no such difference as to support the theory of change. The astronomers of Harvard College, Cambridge (U.S.), can discover no evidence of change with the magnificent refractor of their observatory. They are not, however, it would seem, opposed to the theory that changes may possibly take place upon the moon's surface, since they announce the occurrence of phenomena in Aristarchus, apparently due to the down-flow of lava-streams. Mr. Huggins also has given a view of Linné and a paper on the subject of Schmidt's discovery, in which he appears to oppose Schmidt's views. He states that Respighi considers the present appearance of the crater to be identical with that which it has always exhibited; but he adds that Lohrmann's description in 1823, and Mädler's in 1831, do not appear to be in accordance with either Schröter's observations or with the present condition of the object.

It is noteworthy that nearly every observer who has made the moon a subject of special study is convinced that a change has taken place. And not only so, but many distinguished lunarians are of opinion that the appearance of the spot is still changing. The black spot first seen on Linné by Mr. Buckingham on Dec. 14 under morning illumination, next by Herr Schmidt on December 26 under evening illumination, and resolved into a crater by Secchi on February 11, has now become so distinctly visible as to leave little doubt that the orifice in Linné has become enlarged in the interval.

The question has now arrived at a very interesting stage, and we trust that observation will be diligently pursued.

In connection with this subject we may note that Mr. Birt has just issued two lunar maps, in red outline, so that observers who find any traces of change may mark in the alterations in black ink. These maps are on the scale of 200 inches to the moon's diameter, and comprise the space included between 0° and 6° West longitude, and 0° and 10° South latitude.

Astronomers are of opinion that we may look this year for a recurrence of the November shooting-star shower. Assuming the position of the meteor-stream to have remained unchanged, the maximum display should take place at about seven o'clock on the morning of November 14. But if we assume the shifting of the node (investigated by Adams) to take place uniformly, the epoch of maximum intensity must be placed at about twenty minutes past seven or five minutes after sunrise. This determination, however, does not take into account temporary disturbances in the figure of the ring. The progression of the nodes is not uniform, but subject to variation; neither is the ring always in one plane; and occasionally one of the nodes may regrede for a time. From the position of Jupiter it would appear that the node we traverse in November is at present regreding. This would make the passage occur somewhat earlier, and it seems not unlikely that the maximum display will occur some time before sunrise on the morning of November 14th. The beginning of the display may be looked for several hours earlier.

Jupiter was seen without satellites by several observers on the evening of August 21. The only noteworthy fact we hear of in connection with this phenomenon, is the observation that the shadow of the fourth satellite appeared larger than that of the third, though the third is the larger satellite. This observation, if confirmed, would show that the apparent dimensions of the shadow depend rather on the extent of the penumbra than of the true shadow.

Mr. Proctor has obtained a new determination of Mars's rotation-period. Mädler's determination, founded on seven years' observations, makes the period 24h. 37m. 23·8s. Kaiser extending his calculations over a longer interval obtained 24h. 37m. 22·6s. Mr. Proctor's determination combines observations by Hooke in 1665, by Sir W. Herschel in 1783, and by Dawes in 1864. The result is a period of 24h. 37m. 22·75s., with a probable error of one-fiftieth part of a second.

Mr. Stone has formed a table exhibiting the probable dimensions of seventy-one asteroids. On the assumption that their surfaces have equal reflective powers, the apparent brilliancy of these objects enables us to determine their relative dimensions. Mr. Stone then converts these results into miles by adopting the diameters of Ceres and Pallas resulting from the observations of Sir W. Herschel and Lamont. We append the diameters of the five largest and of the five smallest asteroids:—

Vesta	214 Miles.	Themis	24 Miles.
Ceres	196 „	Asia	22 „
Pallas	171 „	Maia	18 „
Juno	124 „	Atalanta	18 „
Hygeia	103 „	Echo	17 „

Mr. Huggins has been able to analyze the light of another comet with the spectroscope. On May 4th and 8th he made observations of Comet II, 1867. In the telescope the comet appeared to consist of a slightly oval coma, surrounding a minute and not very bright nucleus. The latter was not central, but nearer to the following edge of the coma. The light of the coma formed a continuous spectrum. Mr. Huggins was unable, on account of the faintness of the nucleus, to distinguish with certainty the spectrum of its light from the broad spectrum of the coma on which it appeared projected. Once or twice he suspected the presence of two or three bright lines, but of this observation he was not certain. He considers that this small comet is probably similar in physical structure to Comet I, 1866.

Mr. Peters, of Hamilton College Observatory, Clinton (U.S.), has discovered another small planet, the sixth of his discoveries, the 92nd asteroid, and the 100th primary member of the solar system.

It has been discovered by Mr. Buckingham that the brilliant Vega, long known as a wide optical double, has two minute companions. Whether we are to look on Vega as a true triple star remains as yet undetermined.

Proceedings of the Astronomical Society.

Mr. Airy discusses the curious but annoying tendency which is occasionally seen in the telescopic discs of stars to become triangular, when the wind is in the east or south-east. Mr Dawes's observations suffice to show that the peculiarity does not depend on the object-glass of the telescope. Mr. Airy is disposed to refer the phenomenon to the derangement of the nervous system which usually accompanies an east wind. In a remarkable instance mentioned by Mr. Dawes, east wind and fatigue were combined. Mr. Dawes himself, however, considers the phenomenon to be certainly independent of the observer; a view coincided in by Captain Noble, who rejoices in the digestion of an ostrich, but yet has been troubled by "triangular nights."

Another subject, touched on by the Astronomer Royal, is dealt with more at length by Captain Noble. We refer to the alleged change of focus required in observing stars widely separated in altitude. Captain Noble's observations appear to show that in the very finest observing weather no change of focus is required. But when, as is usual, there is an appreciable amount of vapour near the horizon, it becomes necessary to shorten the focus of a telescope directed to low objects.

Mr. C. Piazzi Smyth, Astronomer Royal for Scotland, supplies an abstract of a paper on the earliest provable traces of good

practical astronomy. He arranges ancient buildings into three classes:—

1st. Those which have no definite astronomical position.
2nd. Those which are oriented so as to have the *diagonals* of their bases towards the cardinal points.
3rd. Those which are oriented so as to have the *sides* of their bases towards the cardinal points.

The diagonal method prevailed in Mesopotamia, and its most splendid example is the temple of Nebo (devoted to all the Planets) at Babylon. The direct form characterizes the Pyramids. Smyth finds by comparing his own measures of the Great Pyramid with Sir H. Rawlinson's measures of the Nebo building, that the former, though 1,500 years older, is oriented sixty times more accurately than the latter.

Major Tennant supplies a paper "On the Expansion of Brass Pendula used in the Indian Trigonometrical Survey." These pendula were swung in a vacuum apparatus, at a very low pressure of atmosphere. There is an anomaly in the results, which would appear to show that at a pressure of only 5 inches of mercury the coefficient of expansion of the brass pendulum must be not only increased, but is actually 13 per cent. greater than has ever before been assigned to brass. It would be singular if it should appear that the size of a solid may, under certain circumstances, be subject to a variation due to pressure alone.

Messrs. De la Rue, Stewart, and Loewy discuss some recent observations and remarks of Hofrath Schwabe's regarding sun-spots and other solar phenomena. Schwabe notices certain phenomena on the surface of the sun, which he has noticed since last December, and which he remembers to have before observed, but only at the time of a minimum in the number of sun-spots. The phenomena are:—1st, a total absence of faculæ or faculous matter; 2nd, the absence of the usually observed scars, pores, and similar appearances; 3rd, an equal brightness of the whole surface, the limb being as luminous as the centre. At Schwabe's request the observations made at the Kew Observatory were carefully gone over. It was noticed that the phenomena occur only in years of minimum spot-frequency. Schwabe is disposed to trace a connection between sun-spots and meteoric showers; and it certainly happens that the two epochs at which the phenomena he describes have been presented, coincided with the great shooting-star showers of 1866 and 1833. It also happened that in the year 1848, which is the middle of the 33·25-years period there was a maximum of spots. But it does not seem easy to reconcile the eleven-years spot-period with the 33¼-years shower-period. If there had been a steady increase of spots from 1833 to 1848 and then a decrease to 1866 there would have

appeared to be some foundation for Schwabe's theory, but as there occurred a minimum of spots in 1844 and another in 1855, we can understand that Messrs. De la Rue, Stewart, and Loewy should not regard Schwabe's views with favour. They record that on February 12th, 1844, and from June to August, 1855, the sun was without spots or faculæ.

Professor Brayley points out the importance of the spectroscopical examination of the vicinity of the sun when totally eclipsed, for the determination of the nature and extent of its luminous atmosphere. He considers that this atmosphere is partially identical with the Zodiacal Light, and he suggests that an attempt should be made to determine the true nature of the Zodiacal Light by means of spectrum analysis.

Professor Brayley adds that he has arrived at the conclusion that in all probability the bright-line or monochromatic spectra, from which Mr. Huggins has inferred the gaseous constitution of certain nebulæ, are in reality due to the luminous atmospheres of their constituent stars or suns. We believe that Mr. Huggins has already considered this view, and shown it to be inconsistent with known laws.

Mr. Stoney supplies a paper "On the Connection between Comets and Meteors." In January last M. Leverrier pointed out that the streams of meteors which produce star-showers must have been in compact clusters when they underwent the great perturbations which brought them into permanent connection with the solar system. And Mr. Graham has shown that the meteoric iron which reaches the earth must have been at some previous time red-hot; and that when last red-hot it was acted on by hydrogen under considerable pressure—a pressure of perhaps six or more atmospheres. Mr. Stoney makes use of these inferences in the endeavour to trace what the physical connection between comets and meteors has been. We must point out one important point in which his argument fails. He lays great stress on the difference between the assumed period of the November shooting-star system and the period of Tempel's comet; the former 33·25 years and the latter 33·18 years. In fact, his argument seems to require that some such difference should exist. But in the first place it is well known that the period of $33\frac{1}{4}$ years assigned to the meteors by Adams and Leverrier was never meant for more than a first approximation, and that a period of 33·18 years would account quite as well for all the phenomena yet observed. In the second place, we have no assurance that 33·18 years is the exact period of Tempel's comet. This is Dr. Oppolzer's determination, but other calculators obtained different results. We have assuredly no evidence that the difference of ·07 years between the periods of the meteor-stream and comet is one that can be insisted upon.

Professor Masters, of Kishnaghur College, Bengal, describes a shower of meteors seen at 2 A.M. on December 12. They shot divergingly and with great rapidity from a point situate in about 136° of right ascension and 29° or 30° of north declination.

Mr. Stone has estimated the longitude of the Sydney Observatory from observations of the moon and moon-calculating stars made in the years 1859 and 1860. His result gives for the difference of time between Sydney and Greenwich, 10h. 4m. 47·32s.

4. BOTANY, VEGETABLE MORPHOLOGY, AND PHYSIOLOGY.

ENGLAND.—*A Handy Book for Collectors of Cryptogams.*—The Rev. W. Spicer has translated, and Mr. Hardwicke has published, a little book on Cryptogams, by Johann Nave, which we feel sure must be very useful to those who wish to study and collect these plants. Methods of preparing and collecting Marine Algæ, Diatoms, Desmids, Fungi, Lichens, and Mosses are given in great detail. Strange instruments to be used in tearing or raking up sea-weeds are figured and described, and all the various appliances in favour with collectors of Diatoms and Desmids are brought before the reader. Twenty-six neat little plates, containing drawings of the most striking forms of the plants to which the volume is dedicated, are dispersed through its pages. The book is in size small enough for the pocket, and may fairly be recommended to all who are in want of instruction in the somewhat difficult and careful manipulation required in order to preserve specimens of Cryptogamic plants.

Sowerby's English Botany.—The new, greatly enlarged, and revised edition of this celebrated work, now being published under the direction of Mr. Boswell Syme, with popular descriptions of plants by Mrs. Lankester, has come to the conclusion of its seventh volume. Nearly four-fifths of the British Flora have now been completed, the last part issued finishing with the Amarantaceæ. Whilst this is going on, Professor Babington, of Cambridge, is supervising the issue of a supplement to the previous edition of 'Sowerby's Botany,' which is to contain descriptions and figures of all the species of plants recognized as British since the issue of the original work. Mr. Salter, late of the Geological Survey, is executing the plates, and Professor Babington's name is a guarantee for the letterpress. There appears to be some difficulty in obtaining subscribers for this supplement, which, however, we can heartily commend.

The Botanical Department of the British Museum.—The principal business of the department during the past year has, we

learn from the report, consisted in the re-arrangement (with very large additions) of the general collection of *Algæ*, of the extensive order of *Euphorbiaceæ*, of the *Lycopodiaceæ*, *Nymphæaceæ*, and of a portion of the *Compositæ*. Also in the naming, arranging, and laying into the general Herbarium of the remainder of Mr. Charles Wright's extensive collections made in Cuba and New Mexico; of the extensive collection formed by the late Mr. David Douglas, in North Western America and California; of a large number of Ferns, collected in Ceylon by Mr. Thwaites, in Venezuela by M. Moritz, and in English gardens by Mr. John Smith; of *Piperaceæ*, from various collections; of Dr. Wallich's collection of Nepalese Oaks; of numerous plants from Brazil and from the Arctic regions; of palms from various regions; of numerous European collections, and of several important collections of Cryptogamic plants, including American and other Mosses. Also in the examination and arrangement of the valuable collection of *Cycadeæ*, presented by Mr. James Yates; of plants from the Tyrol; Ferns purchased from Mr. John Smith, of Kew; of fruits of *Capuliferæ* and *Coniferæ*, in the general fruit collection; of recent and fossil woods; and of the late Dr. Greville's very extensive and important collection of *Diatomaceæ*. Altogether, this seems not a bad year's work, but those who know the vast stores of hay packed away in the recesses of the Botanical Department of the British Museum will feel that even thus they may never live to see the national Herbarium arranged throughout.

Quinine Plants in India.—"It is a good thing that India seems likely to be able to supply the whole world with quinine, for not only was the American supply uncertain, it was actually threatened with extinction, owing to the reckless way in which the Indians killed the trees in the process of stripping, planting of course no new ones. Mr. M'Ivor, who has been ably seconding Mr. Clement R. Markham's efforts at chinchona planting, finds that by removing only one long strip of bark and immediately covering the wound with moss the bark is renewed, provided the cambium be not injured. The new bark, moreover, is thicker and richer in alkaloids than the original one. Indeed, Mr. Broughton, the newly appointed 'quinologist' at Ootacamund, tells us that the average yield of cultivated plants is nearly two per cent. higher than that of the wild American samples—7 per cent. instead of from 4·16 to 5·66 per cent. The only drawback is that the kind which grows most freely in India is the red bark, the quinine from which is usually mixed with a considerable portion of chinchonidine and other allied alkaloids, along with resin and colouring matter not easily separable. Still, however, since we shall use probably more and more quinine every year, it is better to have the mixture than none at all. Mr. Broughton suggests that

these 'amorphous alkaloid substances' may have virtues of their own; but possibly, with more perfect processes, they may be found separable. Anyhow, it is better to take what India can give us for dispensary use, than to prepare (as they do in some dispensaries) their *mistura quiniæ* out of concentrated infusion of quassia and calumba, with a dash of aromatic sulphuric acid."

It is reported that Mr. Clement R. Markham is to join the Abyssinian expedition in a civil (scientific?) capacity.

France.—*Monstrosities becoming New Species in Plants.*—M. C. Naudin, in a late number of the 'Comptes Rendus,' mentions some very remarkable cases of this phenomenon, which have, of course, a very close bearing on Darwin's hypothesis. The first case mentioned is that of a Poppy (*Papaver officinale*), which took on a remarkable variation in its fruit—a crown of secondary capsules being added to the normal central capsule. A field of such poppies was grown, and M. Göppert, with seed from this field, obtained still this monstrous form, in great quantity. Deformities of Ferns are sometimes sought after by fern-growers. They are now always obtained by taking spores from the abnormal parts of a monstrous Fern, from which spores Ferns presenting the same peculiarities invariably grow. Some facts with regard to gourds are mentioned, but the most remarkable case is that observed by Dr. Godron, of Nancy. In 1861 that botanist observed, amongst a sowing of *Datura tatula* (the fruits of which are *very* spinous), a single individual of which the capsule was perfectly smooth. The seeds taken from this plant all furnished plants having the character of this individual. The fifth and sixth generations are now growing without exhibiting the least tendency to revert to the spinous form. More remarkable still, when crossed with normal *Datura tatula*, hybrids were produced which, in the succeeding generation, reverted to the two original types, as true hybrids do. M. Naudin is not very happy in his remarks upon these highly interesting facts. He urges that they give reason to believe that the origin of species by transmutation has not been a very slow process of natural selection; but rather that monstrosities have been produced right and left, according to the Lamarckian speculation.

Germany.—*The Potato.*—A wealthy citizen of Berlin has applied to the municipality of that town for a site on which to erect a statue of Francis Drake, as the introducer of the potato into Europe, and offers to subscribe 2,250*l.* towards the statue. This seems an easy way of settling the doubt lingering about the early history of the potato, and to which the corrupted Spanish name which the plant bears in English, and the corrupted Italian it bears in German, or the unmeaning French and Dutch ones, give no clue.

The Colouring Matters of Algæ.—Dr. Cohn, in a paper to which

we recently referred, has distinguished two bodies soluble in water, the one found in *Phycochromaceæ*, the other in *Florideæ* in conjunction with Chlorophyll, to the first of which he gives the name Phycocyan, and to the second Phycoerythrin. These remarkable bodies give very distinct absorption-bands when examined by means of the spectroscope, and are also highly fluorescent, Phycocyan giving a fine carmine reflection, whilst the light it transmits is pale blue, and Phycoerythrin giving a yellow fluorescence, and transmitting the red rays. At a recent meeting of the Microscopical Society of London, Mr. Sheppard exhibited a fluid, having the properties of a solution of Phycocyan, which he had obtained from a vegetable growth in a spring in Kent. He contended that the colour was produced by the action of monads on albuminous substances which he had placed in the water with the vegetable matter. It appears, however, that the vegetable encrustation abounded in Oscillariæ, *Batrachospermum*, &c., and from the drawings and description given of the spectrum of the fluid and its fluorescence, there is no doubt that he had simply obtained a solution of the Phycocyan of Dr. Ferdinand Cohn. The colouring matters of the lower forms of plants and their relations to Chlorophyll and the physiology of plant-life form a very important and almost unexplored field of research.

5. CHEMISTRY.

(Including the Proceedings of the Chemical Society.)

But few papers call for notice on this occasion. The subject of water-analysis continues to attract a good deal of attention; and additional interest has been given to the matter by the communications of Professor Wanklyn and Messrs. Chapman and Smith. The first-named gentleman read a paper on the subject at the last meeting of the Chemical Society, an abstract of which will be found in our report of the Proceedings of the Society. Several joint communications have also been made to the 'Laboratory' during the past three months.

The researches of the gentlemen named have been devoted to the determination of ammonia and matters capable of yielding ammonia; and their results differ widely from those of other experimenters. We are told, for example, that the waters we have hitherto been taught to consider the purest and best fitted for town supplies, such as Loch Katrine and Bala Lake water, contain a larger amount of albumenoid putrescible matters than the waters at present supplied to the metropolis. Thus, quoting from Pro-

fessor Wanklyn's table which gives the results in "parts in 1,000,000, *i.e.* milligrammes in a litre," there is in—

Description of Water.	Ammonia, as such and as urea.	Albumenoid ammonia.
Water from Bala Lake	0·01	0·25
Loch Katrine, from main in Glasgow . . .	0·02	0·13
Woodhead water supplied to Manchester . .	0·01	0·07
Thames water supplied to London by West Middlesex Company	0·01	0·064
New River	0·01	0·05

These results, it will be seen, differ very widely from those of Dr. Frankland, and the whole subject seems to require further investigation. The process by which Professor Wanklyn obtains the albumenoid ammonia will be found in the abstract of his paper.

While on this subject we may quote the directions given by J. Loewe for the separation of organic matters from a water.*

In the first place the water is boiled until all carbonic acid is expelled. Any deposit is then collected, washed, and boiled with distilled water, adding at long intervals crystallized chloride of ammonium as long as any odour of ammonia is given off. A solution of acetate of copper is then added as long as a precipitate is produced. This precipitate is decomposed by sulphuretted hydrogen, and the filtered solution is evaporated to dryness on a water-bath. The author has only obtained traces of organic matter in this way. The water separated from the precipitate produced by boiling is now concentrated, and when cold, acetate of lead is added. The precipitate is first washed with boiling water to remove chloride of lead, and then with hyposulphite of soda to remove sulphate; there then remains only the organic compound of lead. To secure all the organic matter the liquor decanted from the acetate of lead precipitate must be treated with sub-acetate of lead; this second precipitate will, besides the organic compound, contain oxy-chloride and sub-nitrate of lead. These being got rid of, the mixed lead precipitates are decomposed by sulphuretted hydrogen, and the solution is filtered and evaporated. It is said that the residual organic matter obtained by the author was free from nitrogen; but we are not told what water he examined.

W. Heintz† gives a method of determining the amount of solids, both organic and inorganic, which does not much differ from that usually employed by careful chemists. The author evaporates below 100° C. sufficient water to leave from 0·3 to 0·6 gramme of

* 'Zeitschrift für Chemie.' New Series, V. ii., p. 595; and 'Bulletin de la Société Chimique de Paris,' June, 1867, p. 497.

† 'Zeitschrift fur Chemie.' New Series, V. ii., p. 586.

residue, which he then keeps at 150°, until no loss of weight is observed. This gives the total residue. He then gradually ignites in a platinum crucible—allowing only a part to come to a red heat —until the residue is white, then moistens with solution of carbonate of ammonia, dries at 150°, and reweighs. The difference is very nearly the weight of the organic matter. But as the carbonate of magnesia will have undergone some alteration, to be exact, the author determines the carbonic acid both in the first and second residues, and adds the difference to the second weighing, thereby reducing by so much the organic matter. Heintz states that this method only gives accurate results when the magnesia is present in an organic combination, and when the water is not strongly charged with the oxides of iron and manganese, whose state of oxidation may be altered by the ignitions. The presence of chloride of magnesium is also a source of error, as all chemists will understand.

In technical chemistry one noteworthy fact is the process invented by M. Paraf-Javal, for the Transformation of Liquid into Solid Fats. It was known that under the influence of a strong alkali oleic acid splits up into acetic and palmitic acids This fact the inventor applies industrially as follows:—He heats one part of oleic acid with two or three times its weight of hydrate of potash almost to the fusing point of the potash. A large amount of hydrogen is disengaged in the reaction that ensues, and a porous, swollen mass results. The sudden collapse of this mass indicates that the reaction has ended. Water is now added in small quantities, so as to obtain a strong alkaline solution in which the soap formed is insoluble. The soap can thus be separated, and the greater part of the alkali recovered. When separated the soap is dissolved in water and afterwards precipitated by common salt. It is then decomposed by treatment with an acid, and the palmitic acid is purified by distillation. The liquid from which the soap is separated will, of course, contain an acetate of the alkali. This can be separated and the acetic acid obtained by means known to all chemists. Soda, it is said, may be used in place of potash. It is right to say that this process has been patented in France.

A method of obtaining caustic baryta cheaply is a great desideratum; and we give one recently published by M. Tessie du Motay, which, however, we fear is not likely to receive an extensive application. The inventor takes carbonate of baryta, mixes it into a paste with fat resin and charcoal, and burns the mixture in a reverberatory furnace. In this way the carbonate is reduced and the baryta is left mixed with some charcoal. The latter is burned away by passing a current of oxygen through the furnace, and the heat developed in this operation is so great as to prevent the recombination of the baryta with the carbonic acid produced. Baryta

thus obtained is to be converted into peroxide of barium to furnish peroxide of hydrogen for bleaching purposes.

A new kind of artificial stone invented by M. Sorel deserves a passing notice. A strong solution of chloride of magnesium will consolidate a large amount of calcined magnesia, forming an insoluble oxychloride of magnesium, resembling the oxychloride of zinc proposed by the same inventor for stopping teeth. When, however, a weaker solution of the chloride of magnesium is used with some calcined magnesia, the mixture has the power of holding together fifteen or twenty times its weight of sand and other materials which set into a substance sufficiently hard to be used for flags and tiles, and which may be coloured by ordinary mineral colours for ornamental purposes.

The space we have in this number only allows the mention of the publication of useful practical papers "On the Analysis of Cast Iron," by Dr. G. E. Tosh;* and also "On the Practical Losses of Sulphur in the Manufacture of Oil of Vitriol," by Mr. C. R. A. Wright.†

Proceedings of the Chemical Society.

On the 6th of June, Sir B. C. Brodie delivered a lecture to an unusually large audience, "On the Mode of Representation afforded by the Chemical Calculus, as contrasted with the Atomic Theory." For this lecture and the interesting discussion which followed it we must refer our readers to an admirable report in the 'Chemical News' for June 14. And those who wish to see the opinions of some other chemists, mathematicians, and physicists on Sir B. C. Brodie's system may consult the papers of Professor Williamson and Mr. Stanley Jevons in the 'Laboratory;' and the articles of Professor Wanklyn and Dr. Crum Brown, in the 'Philosophical Magazine' for August and September.

The last meeting of the Society was held on June 20, when Mr. W. H. Perkin read a paper "On some new Derivatives of the Hydride of Salicyl;" Dr. Gladstone read a second paper "On Pyrophosphoric Acid;" Dr. Phipson gave an "Analysis of a Biliary Concretion found in a Pig, and a new Method of preparing Biliverdin;" Dr. Stenhouse made a communication on the action of Chloride of Iodine on Picric Acid; and Mr. Henry Bassett read a short paper "On Julin's Chloride of Carbon." A paper by MM. J. A. Wanklyn, E. T. Chapman, and M. H. Smith, "On Water-analysis: Determination of Nitrogenous Organic Matter," was also read. As the subject of this paper is of great public interest we give

* 'Chemical News,' Aug. 9 and 23, 1867. † Ibid., Aug. 23 and 30.

a short abstract. The peculiar feature of the method is the estimation of the amount of nitrogenous organic matter by the amount of ammonia which is actually formed by distillation with carbonate of soda, caustic potash, and permanganate of potash. Direct experiments have shown that all the nitrogen in urea, gelatine, and albumen are obtainable in the form of ammonia by the method of treatment described; and has disclosed, the authors say, the singular fact that boiling with a caustic alkali liberates one-third the nitrogen of albumen and gelatine in the form of ammonia, and that a subsequent boiling with permanganate of potash liberates the other two-thirds. Thus the nitrogen of urea is obtainable as ammonia by boiling with carbonate of soda; and that of albumen by the caustic alkali and permanganate. We have therefore the means of distinguishing between ammonia from the two sources. The method pursued is briefly as follows: Free ammonia is first estimated in the water by Nessler's test, as described by Dr. Miller. A litre is then distilled with a little carbonate of soda. In this distillate will be found the ammonia from urea. The distillation is interrupted when ammonia ceases to pass, and caustic potash being added to the contents of the retort the distillation is again proceeded with. In the distillate now collected there will be ammonia representing one-third the nitrogen in the albumenoid matters in the water. The distillation is again interrupted and crystals of permanganate of potash are added, enough to give a deep violet tint, and once more the distillation is continued, now almost to dryness. This final distillate will give the remaining nitrogen in the form of ammonia. We must add that all the estimations of ammonia in the various distillates are made with Nessler's test-liquor. For quantitative examples of the method we must refer our readers to the original paper, published in the 'Journal of the Chemical Society' for September.

6. ENGINEERING—CIVIL AND MECHANICAL.

We have, this quarter, to chronicle a more than usual extension of open lines of railway, some of which, too, are of the first importance.

In August last, two new Welsh railways were opened. The one from Aberystwith to Carmarthen, which, by completing a link in the western chain of railways running through the principality, opens the new route between the manufacturing districts of South Lancashire and the mineral districts of South Wales. The other—the Cambrian Railway—affords an unbroken route between Aberystwith and Carnarvon.

In India, the extension of the East India Railway from Allaha-

bad to Jubbulpoor was opened on the 2nd May last. The only gap now remaining in the line from Bombay to Calcutta is between Khundwah and Jubbulpoor, which, it is expected, will be completed by May, 1868. In the Punjab the line from Umritsur to the Beas has just been opened, as has also a branch railway between Lucknow and Cawnpore in Oude. The East India and the Great Indian Peninsular Railways are busily engaged in laying down a second line of rails on portions of their lines; and the usual government guarantee has been given to the Indian Branch Railway Company for the construction of 672 miles of light railways in Oude and Rohilcund.

On Monday, 26th August, the first engine and train passed over the Mont Cenis Railway from St. Michel to Susa, a distance of 48 miles. The summit crossed is at an elevation of 6,700 feet above the level of the sea, which is attained by a series of steep inclines, worked on Mr. Fell's central rail system.

The Brenner Railroad, between Innspruck and Botzen, has recently been opened for traffic, thus establishing a direct connection between Italy and Central Germany. The summit of the Brenner Pass is 4,484 feet above the sea level.

At Stutgard a new railway terminus has been opened, and a series of small branches intended to complete the railway network of Wurtemburg, have been completed. The Eastern Railway of France has added to its system a section, 28 miles in length, from St. Hilaire au Temple to St. Menehould. This company has now 1,630 miles of railway open. The length of railway in operation in Prussia at the close of 1866 was 5,762⅓ miles, which had been completed at an expenditure of 90,000,000*l.*

The Pacific Railway, intended to connect the railroad system of the United States with California, and which is now under construction, will, in connection with the other lines of railway already completed, cross the Continent in a direct line from New York on the Atlantic, to San Francisco on the Pacific Ocean, having a total length of 3,300 miles.

The fourth of the six great lattice girders, intended to form three spans, of 300 feet each, over the Mersey at Runcorn, was let down to its bearings on June 11th. This bridge will carry the London and North-Western Railway by a direct line to Liverpool. The last girder is expected to be in its place by Christmas next.

The Dutch government has determined on the construction of the Mærdyk bridge, between Mærdyk and Willemsdorf. This work, which will be 1½ miles in length, will directly unite the railway network of the Low Countries to the Belgian and French lines.

The Cincinnati Suspension Bridge, U.S., which has recently been completed, has a clear span between the centres of towers of 1,057 feet, and is the longest suspension span yet executed. The

Susquehanna bridge, at Havre de Grace, U.S., is now nearly completed. It is being constructed to unite the hitherto severed portions of the Philadelphia, Wilmington, and Baltimore Railroad. The superstructure, which is for a single line, is of wood, built on the Howe plan, with arches, and consists of twelve spans of 250 ft. 9 in., and a draw span of 174 ft. 9 in. The whole distance between the abutments is 3,273 ft. 9 in. Arrangements are in progress for building a second suspension bridge across the Niagara. This new bridge will be much larger than its neighbour below, the clear span of which is 822 feet.

The East India Irrigation and Canal Company has at last been entrusted with the carrying out of a system of irrigation from the Soane River, in the lower Provinces of Bengal. Had this work been undertaken when it was first designed by Colonel Dickens, much of the past and present calamities of famine in those districts might have been averted.

A prospectus has been issued of the Valparaiso Waterworks Company, to supply that city with water through a canal to be cut from the Aconcagua river, flowing from the Andes. This canal, a portion of which has already been completed, is at the same time calculated to yield a revenue by furnishing water for irrigation to the lands throughout its course.

Three companies have recently been started for establishing a through line of telegraph between England and India. The lines of one company are proposed to pass through France, Italy, Sicily, Malta, Alexandria, and Suez, to Bombay; whilst another would pass through Prussia, Russia, Persia, and along the Persian Gulf to Kurrachee. The third company—which we believe has amalgamated with the first—proposed to carry independent lines from Falmouth to Gibraltar, Malta, &c.

A contract has been concluded for the manufacture of a new cable, to be laid by the Submarine Telegraph Company, between England and Belgium.

Both the shore ends of the Florida and Cuba cable were successfully laid early in August last, but just as the splice was about to be made, the cable suddenly parted about half-a-mile east of the buoy, and the ends sank into the sea.

The foundation stone of the Holborn Valley Viaduct was laid on Monday, June 3rd. Within the past century a total sum of 6,742,853*l.* has been expended by the Corporation of London on public works, buildings, and street improvements.

The American life-raft, which recently crossed the Atlantic in forty-three days, is formed of three cylinders, charged with air and connected by canvas, stiffened by planking. She is 24 feet long, 12½ feet broad, and carries two masts.

A company has been formed to remedy the obstacles which

the bar of the Mississippi offers to navigation. The system which this company proposes to apply to the relief of ships consists of an apparatus of caoutchouc, forming a kind of floating dock, which will be manœuvred with the aid of two tugs. The company hopes by this means to raise to the extent of 8 feet ships drawing 20 feet of water, and to enable them to go over the bar in less than three hours.

The drainage works of Eastbourne have recently been completed and opened.

On the subject of docks, &c., we have to report the admission of water into the Millwall Docks, on the Thames, on 29th August last. On the 1st idem, the first stone of the new graving dock at Malta was laid; this dock, when completed, will be the largest ever constructed, its dimensions being—length, 468 feet; width, 104 feet, and depth, 39 feet. A new slip dock has recently been opened on the Clyde, capable of taking in ships of 2,000 tons; it is 850 feet long, and 57 feet broad. A new floating railway pier at Burntisland, which has been under construction for the past two years, has just been completed. The pier commences about 330 yards east of the Burntisland passenger station, and extends for 1,000 feet in a south-westerly direction, thus forming a harbour which is accessible at all states of the tide.

A process is now being carried out by Messrs. Whitworth, of Manchester, of subjecting steel to a high pressure during the process of casting; the object being to obtain sounder castings, and to do away with the necessity for great "heads" of metal. Mr. Whitworth is also endeavouring by hydrostatic pressure to effect the rolling, or otherwise shaping, under pressure, of cast-steel in the liquid state. Mr. A. L. Holley, of Harrisburg, U.S, has recently patented a plan for casting Bessemer steel ingots from the bottom instead of from the top as is usual; and it is found that ingots thus cast are square and sound at the top as well as at the bottom, and they are more free from cracks and external honeycombs, and much smoother than ingots cast from the top.

A new form of tyre-lathe has recently been introduced by Messrs Greenwood, of Leeds, which has been designed to facilitate the boring of railway tyres, by enabling the whole operation to be completed without shifting the work in the machine, the arrangement being such that cutting tools can be simultaneously brought into action on the opposite faces of the tyre, and also on its inner surface.

7. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

The energy of the Secretary of the Palæontographical Society (the Rev. T. Wiltshire) has borne fruit in the appearance this quarter of another volume of the Society's Monographs,—that for 1866,—after an interval of only six months from the date of publication of the one we last noticed.

This volume opens with a second instalment of Dr. Duncan's Monograph of the British Fossil Corals, in which are described the Zoantharia from the Liassic zones of *Ammonites planorbis* and *A. angulatus*. These zones have recently been the subject of much discussion, especially as regards their more or less close relationships with those above and below. We have recently given a summary of Dr. Duncan's interpretation of the coral evidence, in recording the publication of his paper "On the Madreporaria of the Infra-Lias of South Wales," so on this occasion we shall confine our attention to some of the author's considerations on the philosophy of zone classifications generally. The Liassic and Oolitic formations have been subdivided into a number of "zones," each of which is characterized by, and named from, the occurrence of a certain species of Ammonite. The more enthusiastic advocates of this classification seem to believe that the range of other organisms is more or less co-extensive with that of the Ammonites, and that the latter, being abundant in these deposits, and tolerably easy of determination, afford the *easiest* means of identifying the zones; it has also been stated that they are the *best* test of horizons, because their range is less uncertain than that of other organisms. Dr. Duncan's researches into the distribution of the Liassic Corals have not enabled him to strengthen the arguments in favour of zone classifications; on the contrary, he has been led to the conviction that "the endeavour to give definite horizons to, and to correlate, *Saurian, Insect, Ostrea, Ammonite*, and *Lima* beds has resulted in the production of confusion instead of the reverse;" also "that no stratigraphical Palæontology can be perfect in a classificatory sense, and that *zones of species may have little to do with the notion of time*."

Holding this opinion the author's practice may appear inconsistent with his preaching; but in reality he accepts the principle of a zone-classification in a modified sense. "The groups of Madreporaria have a general relation to certain zones of life and to certain strata; and if they are associated for the sake of a necessary classification with certain Ammonite-zones, it must be understood that it is only an approximative classification, and that both the

Ammonites and the Madreporaria may range out of their supposed restricted zone, or not even be represented in certain portions of its area." In point of fact, Dr. Duncan is one of the few palæontologists who can view the birth and death of the life of a period as symbolized by a line that is elastic, and not rigid.

Mr. Salter's contribution to this volume, being Part IV. of his Monograph of British Trilobites, consists almost entirely of descriptions of the species of the genus *Illænus* and of its subgenera; Mr. Davidson continues his description of the Silurian *Spiriferidæ* and commences that of the *Rhynchonellidæ*; and Professor Phillips makes considerable progress in the description of the Liassic Belemnites.

The volume is illustrated by forty well-executed plates, which are mostly beautiful specimens of scientific lithography, some being English and some French.

The most recent publication of the Geological Survey of India, another contribution to Indian Palæontology,* is a work of more than Indian importance. It contains the first portion of Dr. Stoliczka's description of the Gasteropoda of the Cretaceous rocks of Southern India, including the Pulmonata and the siphonostomatous Prosobranchia; but its general interest will be due to its containing an elaborate essay on the classification of the Gasteropoda—the illustrative examples being necessarily chosen from the Cretaceous fossils of Southern India. It will be sufficient for us to mention here that Dr. Stoliczka's plan is to subdivide the old generic groups, such as *Fusus*, *Murex*, &c., into a number of smaller groups which he considers to be still of generic value. Although, in this course, Dr. Stoliczka has to some extent followed many able conchologists, the plan has not yet found much favour with British palæontologists.

The Journal of the Royal Geological Society of Ireland contains several meritorious papers on drift deposits and theories of denudation. Our space will not admit of our giving analyses of these memoirs; but we may especially draw the attention of our readers to Mr. G. H. Kinahan's "Notes on some of the Drift in Ireland;" and to a very elaborate essay by the Rev. Maxwell H. Close, "On the General Glaciation of Ireland."

In a communication to the Royal Institute of Lombardy,† Sign. Lombardini describes some traces of the Glacial period which he had observed in the great depression of Central Africa. He therefore infers that confirmatory evidence will be found in the mountainous districts of Abyssinia, and in the more southern and tropical regions of Kenia and Kilimandjaro. Collating his results with those of M. Reclus in the Sierra Nevada, and of M. Agassiz in Brazil, he comes

* Palæontologia Indica, vol. v., fasc. 1–4.

† Rendiconti del Reale Istituto Lombardo di Scienze e Lettere. Classe di Scienze Matematiche e Naturali, vol. iii., fasc. 3, p. 85.

to the conclusion that the phenomena of the Glacial period were spread over the whole surface of the globe.

These investigations have a direct bearing on the speculations of Mr. Croll and others, the basis of whose hypotheses is the assumption that the glacial phenomena were limited to extra-tropical regions. Mr. Croll, indeed, has recently published a modification of his original hypothesis to account for changes of climate, namely, alterations in the obliquity of the ecliptic; and has thus got into another controversy with his old opponent, Mr. J. Carrick Moore. The several papers which have been published on this subject will be found in the numbers of the 'Philosophical Magazine' issued during the past quarter.

The geological survey of the Grand Duchy of Hesse has recently made considerable progress; and several sheets of the map with descriptive memoirs have come under our notice. Amongst them we wish especially to draw attention to the map and description of the Section Alzey by M. Ludwig; and to those of the Section Mainz by Herr Grooss. These maps and memoirs furnish us with the most accurate descriptions yet published of two of the most classical of all the German Tertiary localities, and therefore deserve more than a local circulation.

The 'Geological Magazine' for the quarter has contained a large number of original articles, but we have space to notice only two or three of the most important.

In the first place we must draw attention to a paper by Professor King in the June number and an answer to it by Mr. Davidson in the July number, with a notice in the latter of a paper by Mr. Meek —all on the subject of the perforation or non-perforation of certain Palæozoic Brachiopoda. Dr. Carpenter has also taken part in the discussion, and has published papers on the subject in the January and July numbers of the 'Annals and Magazine of Natural History.' The chief cause of the discussion appears to be the rather remarkable fact that two forms of Spirifer (*S. cuspidatus*), though otherwise undistinguishable, are respectively characterized by the perforation of the shell in the one case, and its non-perforation in the other.

The August number of the Magazine is chiefly remarkable for containing a verbatim report of Dr. T. Sterry Hunt's lecture on the chemistry of the Primeval Earth, which was delivered at the Royal Institution on May 31st.

Proceedings of the Geological Society.

An important paper by Mr. Tate "On some Secondary Fossils from South Africa," forms the commencement of the last number of the Society's Journal. It contains descriptions of a large

number of fossils from the Mesozoic deposits of that region, and is enriched by much information on the stratigraphy of the district, brought together by Prof. T. Rupert Jones, F.G.S. The fossils were obtained from two series of deposits, namely, (1) the Karoo Beds, and (2) the Uitenhage Series; and they consist of plants from the former, and plants and shells from the latter. The Karoo Beds include a large series of deposits, the more recent of which (the Dicynodon-strata) have yielded the reptilian remains which have impressed a classical stamp on the South African region, as well as some of the plants now described. Mr. Tate infers their age to be Triassic, chiefly because, while the plants are undoubtedly Mesozoic, the strata are distinctly older than the Uitenhage Series above them.

The Uitenhage Series, which the author infers to be of Jurassic age, has yielded about half-a-dozen species of ferns and a few Cycads, besides nearly forty species of Mollusca, and is probably of the same date as the strata of the Rajmahal Hills and of Scarborough, which yield remains representing those from the South African strata. In the same way the plants from the Karoo beds present a close analogy with those from the Coal-formation of Eastern Australia, and the plant-bearing beds of Burdwan and Nagpur in India, the characteristic plant in all these deposits being a *Glossopteris*, apparently belonging to the same species.

The examination of so interesting a series of Lower Secondary fossils has necessarily led Mr. Tate to compare them with those obtained from the equivalent deposits in Europe, and he has come to the conclusion that while the Upper Trias of Europe presents a remarkable uniformity with its representatives in other countries, the Jurassic series—which is so fully developed in Western and Central Europe, and is reduced in the Mediterranean basin to the beds from the Lias to the Oxford Clay inclusive—in Russia constitute but one formation, and the extra-European developments of the series are more comparable with the Russian than the more Western type. He does not, therefore, regard these South African deposits as corresponding to any particular division of the Jurassic rocks, but considers them rather to represent the whole of the formation, with the exception of the Upper Oolites.

Mr. Boyd Dawkins contributes a second paper on the British Fossil Oxen, namely, on *Bos longifrons*, Owen, and arrives at the conclusion that although it has been found abundantly in the bone-caves and alluvia of the Pre-historic age, it has not yet been proved to have existed in earlier times. He also considers it to be the progenitor of the small Highland and Welsh cattle, and altogether an animal more nearly concerning the archæologist than the geologist.

A most interesting and carefully written paper, "On some Sea-

water Level Marks on the Coast of Sweden," by the Earl of Selkirk, throws great doubt on the received creed as to the rise of land in Scandinavia; and although we cannot admit that his lordship has entirely disproved the belief that the land is gradually rising, he has no doubt done good service by showing flaws in the evidence sufficient to call into action more caution and discrimination on the part of future investigators, than has been exercised by many of those who have hitherto studied the subject.

In a paper "On the Lower Lias or Lias-conglomerate of a part of Glamorganshire," Mr. H. W. Bristow combats Mr. Tawney's conclusions as to the Sutton and Southerndown series, and shows that instead of the latter overlying the former, the two series pass horizontally into one another. Mr. Bristow's experience as a surveyor and Mr. Tawney's deficiency in this respect render it extremely probable that the interpretation of the sections now given is the correct one, and that the Sutton series is not quite so ancient as Mr. Tawney believed it to be.

Mr. J. W. Judd has a most creditable paper "On the Strata which form the Base of the Lincolnshire Wolds," in which he describes at length the various red beds occurring in the Lower Chalk as distinguished from the Red Chalk of Hunstanton (the Hunstanton Limestone of Mr. Seeley), which is probably of the age of the Upper Greensand or Gault, possibly even representating both of these formations, as has been suggested by Mr. Seeley. Mr. Judd distinguishes by the name of the "Tealby Series" a still lower set of strata, the analogies of whose fauna are to be found in the Neocomian fossils of North-western Germany and South-eastern France, rather than in those of the Lower Greensand of the South of England. The geology of the Lincolnshire Wolds has been so much neglected that Mr. Judd has done the work of a pioneer, and, considering the slight information we formerly possessed on the subject, this paper gives a remarkably solid basis for future progress in correlating still more closely the strata of this district with those of other regions; and more especially in defining the relations of the Neocomian strata of the Continent with the English Lower Greensand.

Two papers on *Eozoon*, by Sir W. Logan and Dr. Dawson, contain a complete description of some specimens of that fossil, which consist entirely of carbonate of lime, as well as of the strata in which they were found. The discovery of the specimens of *Eozoon* in this condition is the best possible answer to some at least of the arguments used by Prof. King and Dr. Rowney against the organic nature of the fossil; and in addition Dr. Dawson states that the objections raised by them had been considered by him previously to publishing his first paper on the subject.

We have thus selected out of the Society's Journal some of the

more important of the papers it contains; but several others are worthy of perusal by those interested in the subjects treated of, especially Mr. Boyd Dawkins's paper "On the Dentition of *Rhinoceros leptorhinus*."

It is with sincere grief that we are compelled to announce the death of Mr. W. J. Hamilton, F.R.S., F.G.S., who was one of the magnates of the Geological Society, having been twice its President, and Secretary for a number of years. For an account of Mr. Hamilton's career our limited space compels us to refer our readers to the August number of the 'Geological Magazine.'

8. MINERALOGY, MINING, AND METALLURGY.

Mineralogy.

The characteristic association of certain minerals or their *paragenesis*—to use a convenient term adopted in German science—is a subject deserving the most attentive consideration, whether for its theoretical value, or for its practical bearing on mining enterprise. It is, indeed, by the study of these associations, that we may hope to become acquainted with the conditions under which the minerals were formed; and, by the accumulation of a sufficient number of examples, may eventually be led to generalizations of great practical utility. Even with our imperfect knowledge of the laws of paragenesis, instances are not wanting of discoveries having been made by observing that the presence of one species, perhaps in itself of no value, points in many cases to the occurrence of another mineral which may be of considerable importance. With regard to a substance so highly prized as gold, these observations have, of course, especial interest; and our thanks are, therefore, due to Herr Credner for the painstaking way in which he has noted the different associations of gold that have fallen under his observation during a residence in the gold-fields of Georgia.* In many parts of this State the gold is accompanied by tetradymite or telluric bismuth, a mineral which is also found in our Welsh mines, and in many other gold-bearing districts. South of Dahlonega the metal occurs in a syenitic gneiss; and to the east of the same locality, it is found, with red garnets, in a chlorite-slate; tetradymite being an associate of the gold in both situations. The mode in which the metal occurs in Cherokee County is of considerable paragenetic interest: in the white talcose slate of that county there are found numerous oval concretions of mispickel or arsenical pyrites.

* Beschreibung einiger paragenetisch interessanter Gold-Vorkommen in Georgia, Nord-Amerika. Leonhard und Geinitz's Neues Jahrbuch für Mineralogie, u.s.w. 1867, Heft IV., p. 442.

Externally these nodules are coated with brown iron-ore derived from the decomposition of the mispickel, whilst internally they are traversed by fissures, the walls of which are studded with crystals of scorodite and pharmacosiderite, associated with much native gold, partly in dendritic and moss-like forms, and partly crystallized in cubes and octohedra. Finally, the writer calls attention to the auriferous quartz of Burnt Hickory, S.W. of Ackworth, where the gold is found in association with brown iron-ore and native sulphur. Originally the precious metal doubtless existed in the form of auriferous iron-pyrites; and the decomposition of this mineral has yielded the sulphur and oxide of iron. The sulphur occurs in the cavities of the loose brown iron-ore, and in some cases assumes the form of crystals, pseudomorphous after those of iron-pyrites. To explain the decomposition of the mundic, with the formation of these products, Herr Credner follows the principle suggested long since by G. Rose, to account for similar phenomena in the gold-deposits of Beresow in the Urals; a decomposition which may be represented by the following equation:—

$$2\,FeS_2 + 3\,HO = Fe_2O_3 + 3\,HS + S$$

Professor Nordenskiöld's recent examination of the rich collection of seleniferous minerals in the Stockholm Museum, has led to the detection of small quantities of the rare metal thallium in certain specimens of eukairite and berzelianite, which were obtained some years ago from the copper-mine of Skrikerum in Småland. Associated with these two selenides, there occurs a third mineral, allied to the others in general characters, but distinguished by containing thallium to the extent of not less than 19 per cent. M. Nordenskiöld considers this mineral to be clearly separable as a distinct species, for which he proposes the name of *Crookesite*, as an appropriate honour to the discoverer of thallium, Mr. William Crookes, F.R.S.

Crookesite occurs in small opaque masses, having a vitreous lustre and a lead-grey colour, a hardness of about 3, and a specific gravity of 6·9. Before the blowpipe it colours the flame intensely green, fusing to a lustrous greenish-black enamel. In hydrochloric acid the mineral is soluble. It appears to be a selenide of copper, thallium, and silver; the silver, however, being referred to a trace of eukairite. The formula of Crookesite may be thus written:*—$(Cu_2, Tl, Ag)\,Se$.

In the lignite, or brown coal, of Weissenfels, in Prussian Saxony, there occurs an earthy mineral-resin described some time ago by Professor Kenngott as *Pyropissite*. Of late years this substance has become of considerable economic value from its

* Ofversight of Kongl. Vetenskaps-Akademiens Forhandlingar, No. 10; and 'Chemical News,' July 19, 1867, p. 29.

employment in the manufacture of paraffin. Towards the end of 1865 Herr Stöhr visited the locality, and has lately published the results of his visit in a long memoir,* describing the physical and chemical characters of the mineral, its geological position, and its probable origin. He believes that it has been formed by the alteration of brown coal, and not, as had been suggested, by the *Pinites succinifer*, or amber-yielding pine; for, although true amber occurs in the neighbouring rocks, yet the plant-remains found in immediate association with the pyropissite have no affinity whatever with those of the amber-tree.

The French chemist, M. Mène, whose researches on iron pyrites were noticed in the Chronicles of last quarter, has communicated to the Academy of Sciences his "Analyses of various crystallized and amorphous Graphites."† This paper contains no less than forty original analyses, chiefly of the native mineral, but including also a few artificial graphites, and three analyses of plumbago crucibles. Although we do not observe that these investigations lead to any new deduction, yet original work of this kind, when carefully conducted, must always possess a certain value for comparison with the results obtained by other chemists.

In a short but suggestive paper "On Banded and Brecciated Concretions,"‡ Mr. Ruskin touches upon some obscure points of mineral structure, and treats them with his wonted originality of thought. We presume, however, that few mineralogists will be disposed to accept his conclusions without qualification. The banded structure exhibited by many minerals, such as agate, is commonly regarded as the necessary result of the manner in which the substance was deposited from solution, layer by layer; but Mr. Ruskin, not satisfied with this explanation, imagines that the concentric zones do not represent successive deposits, but that they are concretionary bands which have gradually separated from the surrounding mass, and have arranged themselves in definite form, each band presenting in many cases distinctive characters of its own. Further, instead of believing that in every brecciated structure some dislocating force has shattered the substance, and that the fragments have been afterwards cemented together, he conceives that in many cases—and notably in certain agates and marbles—the apparent brecciation results from the segregation of definite substances from an impure matrix, and the rending asunder of these concretions by subsequent contraction.

Prof. Kenngott, of Zurich, has forwarded to the 'Journal für

* Das Pyropissit-Vorkommen in den Braunkohlen bei Weissenfels und Zeitz. Neues Jahrbuch für Mineralogie, u.s.w. 1867, Heft IV., p. 403.

† Analyses de divers graphites cristallisés et amorphes: 'Comptes Rendus,' 1867, n° 21, p. 1091.

‡ 'Geological Magazine,' August, 1867, p. 337.

praktische Chemie' some "Communications on Richmondite, Osmelite, and Neolite,"* and also "On Pyrophyllite, Hydrargyllite, Pennine, Chlorite, and Clinochlore."† These papers are chiefly occupied by a collation of numerous analyses of the above-named minerals, and by attempts to deduce rational formulæ therefrom.

A careful study of the minerals known as pholerite, nacrite, steinmark, and kaolin, has led Messrs. Johnson and Blake to the conclusion that these minerals are sufficiently related to justify their consolidation into a single species, for which they suggest the name of *Kaolinite*,‡ since the substance is represented in its purest form by the basis of certain kaolins or china-clays. Kaolinite crystallizes in the rhombic system, and has a composition agreeing with that deduced by the late Prof. Forchhammer from his analyses of porcelain-clay, *viz.*—

$$3\ Al_2\ O_3 + Si\ O_3 + 6\ HO.$$

The brilliancy and variety of the tints presented by fluor spar have attracted the attention of M. Wybrouff, who has made them the subject of an elaborate series of investigations, partly chemical, and partly microscopical. These researches show that the fluor spars hitherto examined owe their colours to the presence of certain hydrocarbons, which in many cases have arisen from the decomposition of bituminous limestones. The author has given particular attention to a fetid fluor (Stinkfluss) from Wölsendorf in Bavaria, termed *Antozonite* in accordance with the supposition that it contains the so-called antozone. It may not be unnecessary to remark that Schönbein regards oxygen in its ordinary inactive condition as a compound of ozone, or negative active oxygen ($\bar{O}$), with antozone or positive active oxygen ($\dot{O}$); the latter condition of the element is supposed to exist in the Wölsendorf fluor spar. Wybrouff, however, shows that the odour which this variety emits on friction proceeds, not from the presence of free antozone, but from the decomposition of the organic colouring matter. The connection between the colour and the odour is indeed clearly brought out by his microscopical observations, for which the reader must refer to the original paper.§

Herr Paulinyi, of the Mining School of Schemnitz, has communicated to the Academy of Sciences at Pesth, an account of a new mineral which he has recently detected in a brecciated specimen from a vein at Kremnitz, in Hungary. It occurs in cubic crystals of a black colour and a vitreous lustre, giving an uneven fracture

* 'Journ. f. Prakt. Chem.' 1867, No. 9, p. 6.

† *Ibid.*, p. 17.

‡ "On Kaolinite and Pholerite:" 'Silliman's American Journal of Science and the Arts,' May, 1867, p. 351.

§ Recherches microscopiques sur les substances colorantes des fluorine. Bulletin de la Soc. Imp. des Naturalistes de Moscou. Tome xxxix. p. 150.

when broken, and having a dull-green streak. The mineral, which has a very sweet taste, was found on analysis to have the following composition:—

Sulphuric Acid	45·32
Protoxide of iron	6·66
Peroxide of iron	44·92
Water	1·51
	98·41

From this analysis the following formula may be calculated:—

$$Fe\,O,\,SO_3 + 3\,(Fe_2\,O_3,\,2\,SO_3) + HO$$

The mineral is therefore a hydrous sulphate of the proto- and peroxides of iron; standing between iron-alum and voltaite, but related much nearer to the latter than to the former, yet differing from voltaite sufficiently to admit of its separation as a distinct species, for which Paulinyi proposes the name of *Pettkoite*, after Professor von Pettko.*

In a letter addressed to Professor Dana, and published in 'Silliman's Journal,'† M. Pisani expresses his belief that the mineral called Taltalite, by Domeyko, is only an accidental mixture of oxide of copper, with a fibrous tourmaline rich in iron.

Several analyses of new Swiss minerals have been lately published by Herr von Fellenberg; but, as our limits forbid any detailed notice, it must suffice to say that they relate to a new felspar, at first mistaken for a green talc; to a peculiar serpentine, containing only a small proportion of water; and to a variety of calcite, characterized by the presence of carbonate of strontia.‡

Mining.

The Mineral Statistics of the United Kingdom, which have just been issued from the 'Mining Record' office, make us acquainted with the present state of our mining industries. We shall endeavour to present, as concisely as possible, the condition of last year as compared with the preceding:—

In 1865 we produced—of	Tons.		In 1866 we produced Tons.
Coals	98,150,587	..	101,630,543
Iron ore	9,910,045	..	9,665,042
Tin ,,	15,686	..	15,080
Copper ore	198,298	..	180,378
Lead ,,	90·451	..	91,047
Zinc ,,	17,842	..	12,779
Pyrites ,,	114,195	..	135,402
Gold Quartz	4,282	..	2,927

* Leonhard und Geinitz's Neues Jahrbuch. 1867. Heft IV., p. 457.
† May, 1867, p. 407.
‡ 'Journal für Praktische Chemie,' 1867, No. 9 p. 32.

The quantities of the metals obtained from these ores were as follows:—

	1865.		1866.
	Tons.		Tons.
Iron	4,819,254	..	4,530,051
Tin	10,039	..	9,990
Copper	11,888	..	11,153
Lead	67,181	..	67,390
Zinc	4,040	..	3,192
	Ozs.		Ozs.
Silver from the lead	724,856	..	636,188
Gold	1,664	..	743

The total value of the mineral productions of these islands in 1866 is given as follows:—

Metals obtained from ores raised from the British mines	£14,954,695
Coals, estimated price at the place of production	25,407,635
Earthy minerals, not building stones	1,350,000
	£41,712,330

This and the last year have presented a depression in mining adventure which has not been equalled within the present century. All our mining interests have suffered to a greater or less degree, but the Tin and the Copper Mines of Cornwall and Devonshire have in almost every instance been worked at a ruinous loss. The result of this has been the emigration of more than seven thousand miners, the closing of a great number of mines, and the reduction of the work in many more. We learn from the 'Mineral Statistics' that tin ore in 1859 was 74*l.* 15*s.* per ton; whereas, in 1866, it was only 48*l.* 10*s.* 9*d.* The price of copper ore has also fallen, it being, in 1859, 5*l.* 19*s.* a ton, and in 1866, 4*l.* 11*s.* There has also been a very steady falling off in the production of fine copper during that period.

In connection with mining for the precious metals, a most elaborate and eminently useful volume, 'The Mining and Metallurgy of Gold and Silver' in all parts of the world, has been produced by Mr. John Arthur Phillips, who is already well known by his 'Manual of Metallurgy.' We must content ourselves at present with this passing notice of the appearance of this splendid volume. Its importance is such that it demands from us a careful examination at an early period.

Several sets of experiments have been made on the different varieties of Safety Lamps in use in this country and in Belgium. One set was made some short time since at Newcastle, and more recently another set of similar experiments have been carefully carried out at Barnsley. The experiments in both cases consisted in exposing the safety lamps under trial to regulated currents of explosive mix-

tures of coal-gas and atmospheric air. When gas was made to travel through the box in which the lamps were placed, at the rate of 7·3 feet per second, all the lamps exploded—the ordinary Davy first, and the Stephenson last. In the recent experiments of Messrs. Hutchinson and Wilson, at Barnsley, where the coal-gas of the gasworks was used, it has been suspected that some of the results were due to olefiant gas in the explosive mixture employed. This would certainly render explosion more probable; but all the experiments teach us in an unmistakable manner that, as we have improved the ventilation of our coal mines, we have, by driving the currents of air more rapidly through the ways of a colliery, rendered that which was a safety lamp safe no longer, and the attention of the ingenious must be turned to the construction of a lamp which shall resist the action of currents of explosive gases travelling at from seven to ten feet per second. The results of these experiments promise us the production of a modified form of the Stephenson lamp, which will be a real safety lamp.

The Select Committee on Mining have made their report. They recommend that no boys should be employed in any mine under sixteen years of age, and that the hours of labour should be regulated so as to allow the proper time for rest and recreation.

The truck-system, still prevalent in some parts of the country, is to be repressed. Several new, and in some cases, it would appear, impracticable regulations as to the modes of working collieries are proposed. They also recommend that the present staff of inspectors should be increased—a recommendation to which there appears to be a very general objection, unless the system of inspection is extended far beyond what was originally contemplated by the legislature.

Metallurgy.

There is not much to report of novelty in any of our Metallurgical processes during the past quarter.

The Wilson downward-draught puddling furnace, which is in action at the Bolton Iron and Steel Company's works, is reported of as giving most excellent results. It is said to be producing a ton of puddled blooms to a ton of coal, and that without smoke, and with a minimum waste of metal. Twenty-one hundred weight and a half of pigs per ton of blooms has been reported. Further experiments are, however, necessary to establish this.

The Metallurgical methods of Messrs. Whelpley and Storer are receiving so much attention in the United States and in Canada, that some notice of them cannot but be interesting to our metallurgical readers. Dr. Sterry Hunt, F.R.S., of the Canadian Geological Survey, than whom there cannot be a more competent authority,

has written very fully on those processes, and from his paper we select the following paragraphs:—

1. "The first step in the treatment of ores is their sub-division, which is effected by two novel and ingenious machines, called respectively the breaker and pulverizer. The first of these consists of a horizontal circular table of heavy iron, forty-two inches in diameter, revolving about one thousand times in a minute, having bolted to its upper surface four or more radial bars or blocks of chilled iron, and surrounded by a fixed upright perforated screen. The ore, in fragments not more than six inches in diameter, falling into this aperture, is broken by the revolving bars into dust and small grains, which are ejected through the perforated screen or curb, from which the larger particles are thrown back to complete the breaking. Such a machine with fifteen horse-power will break to the size of sand and coarse gravel eighteen or twenty tons of quartz or hard ore per hour.

"The pulverizer is properly designated as an air-mill, and consists of a horizontal shaft, furnished with arms or paddles, which are made to revolve from one to three thousand times a minute, within an inch of the inner surface of a steel-lined cylinder, varying from eighteen to forty inches in diameter. The previously crushed ore is introduced through an opening in the centre of a plate, which covers one end of the cylinder, and is perforated with numerous small holes.

2. "The calcination of the pulverized ores is effected in what Messrs. Whelpley and Storer call the Water Furnace. This consists of a fire-tower, from twenty to thirty feet high, built of brick, with double walls, and somewhat conical in form, being from three to four feet in diameter at the top, and from four to six at the bottom. Around its upper part are built four fire-boxes, opening into the tower near its summit, which is closed and connected with a large fan-blower. By means of this, besides an abundant supply of air, more or less heated by passing between the two walls of the tower, ore and fuel, in the state of dust, are carried downward into the furnace. The effects obtained by the combustion of charcoal or other fuel pulverized and borne in a current of hot air are very surprising. The finely divided combustible being kindled by the flame drawn from the fire-boxes, burns in the descending current with great energy, and from the comparatively large surface exposed to the action of the air, generates a great amount of heat, and, with an excess of fuel, an intense light. The great fiery blast, nearly filling the tower, can at pleasure be made oxydizing or reducing in its action, by regulating the supplies of fuel and of air. I have seen it at twelve feet from the top, so potent as to heat rapidly to whiteness two feet of a wrought-iron bar an inch in diameter, and cause it, though supported at both ends, to bend like wax beneath

its own weight in thirty seconds after it was placed in the blast. The powerful heating effects which may be obtained by the uses of pulverized fuel are readily understood when we consider that a cubic inch of coal, reduced to particles one five-hundredth of an inch in diameter, will present to the action of the atmospheric oxygen a surface equal to not less than twenty-one square feet.

"The calcination of sulphuretted ores, however, requires but a comparatively low temperature, and an abundant supply of oxygen. The fire-tower of the Water Furnace, being heated to redness, the ore, with or without addition of pulverized fuel, is driven by a small fan into the great current of air down the tower; the sulphur and the base metals are rapidly oxydized and the calcined material falls into the water-tank beneath, while the current of air passes through successive chambers, built over this tank, and open to it beneath. This movement is aided by a large fan-wheel placed at the end of the series, which being furnished with paddles dipping into the water, produces in the final chamber a great amount of spray serving alike to precipitate the suspended dust, and promote the absorption of the sulphurous acid gas. The escape of the excess of this into the air, provided it is not required for further use, is prevented by a second spray-wheel beyond, supplied with milk of lime or some other absorbent.

"In the case of sulphuretted ores of copper, the water-tank is filled with a solution of the chlorids of sodium and calcium, by which, with the aid of the spray-wheel, the sulphurous acid is absorbed, and the oxyd of copper converted into dichlorid. This beautiful process, devised by Messrs. Whelpley and Storer, I have submitted to examination, and have found that the reaction taking place may be represented as involving one equivalent of chlorid of calcium, one of sulphurous acid, and two of cupric oxyd, and giving rise to one equivalent of sulphate of lime, and one of dichlorid of copper,

$$CaCl + SO_2 + Cu_2O_2 = SCaO_4Cu_2Cl.$$

"A solution of chlorid of calcium holding oxyd of copper in suspension, rapidly absorbs sulphurous acid gas, and if sufficiently concentrated, is converted into a white crystalline magma of gypsum and dichlorid of copper. This latter salt I find to be soluble in a boiling hot solution of chlorid of calcium, which, however, again deposits it on cooling, a reaction which may probably be found available on a large scale in separating copper from some other metals. In ordinary cases, however, the precipitation of the dichlorid of copper in the furnace-tank is prevented by the presence in the bath of chlorid of sodium, in which, as is well known, the cuprous chlorid is readily soluble.

"The calcined and oxydized ore falling into the tank, which

extends sixty feet or more beneath the furnace and its chambers, is carried forward with constant agitation, by means of a submerged rotating helix, and at length falls into a well at the extremity, from which it is withdrawn, freed from oxyd of copper, but generally containing a small residuum of unoxydized sulphid, which, if of sufficient importance, is separated by a repetition of the process with the Water Furnace, or by a rapid calcination in a reverberatory, of the mass impregnated with chlorids, by which means the residual copper left by imperfect burning becomes readily soluble in the sulphurous chlorid bath of the water-tank.

"It will be seen that for sulphuretted ores containing gold, the treatment in the fire-tower, with the aid of a bath of water only, affords a simple mode of desulphurization, and leaves the gold particles in a state most favourable for amalgamation, while in the case of auriferous ores containing copper, a similar result may be obtained and the copper which is lost in the ordinary method of working such ores, recovered by means of the chlorid bath.

"It is claimed by the designers of this series of processes that copper can in this way be produced, at about one-third the cost of the ordinary method. The small consumption of fuel and the mechanical facilities afforded for handling great masses of material, are such that the new method will probably be found especially advantageous, in the treatment of low-grade ores, in regions where transportation is difficult and fuel scarce. The patentees have a small experimental furnace, eighteen feet high, at East Boston, but are now erecting at the Harvey Hill Mine, near Quebec, a furnace thirty feet high, which it is expected will enable them to treat fifty tons of seven per cent. ore in twenty-four hours."

9. PHYSICS.

LIGHT.—In a paper "On the Estimation of Star-colours," Sidney B. Kincaid, Esq., has described a metro-chrome, or apparatus for measuring colour. It consists essentially of three parts:—1, a lantern for the production of a constant light; 2, a contrivance for imparting to that light the necessary colour, and so arranged that the proper tinge once produced, a record of it can be obtained, so as to enable it to be reproduced at any time; 3, an apparatus to throw that coloured light into the field of the telescope as an artificial star, which can thus be viewed side by side with the image of the real one. The source of light is a very fine platinum wire, rendered incandescent by a current of electricity transmitted through it from a Smee's battery of two cells. The platinum wire is brought into the focus of a lens, so that the rays of light from the lantern issue

parallel, and therefore come to a focus after passing through the object-glass of the telescope, at the same distance from it as those emitted by a star. The chromographic part of the apparatus consists of a drum rotating about an axis. The drum has in it six equi-distant radial openings—the alternate three of them transmitting the normal light of the lantern, the other three constructed so as to admit flat-sided stoppered bottles containing chemical solutions of different colours. The outer edge of each of the last-mentioned apertures is graduated into ten parts, and each of them can be wholly or partially closed by means of a radial shutter; the other three apertures can be simultaneously closed, wholly or partially, by a triune radial shutter: the edge of one of them is divided into ten parts; and as all are equally affected by the movement of the shutter, the reading applies to the three openings. The drum is made to rotate so as to bring successively the different apertures in front of the lantern; and when the rotation is sufficiently rapid, the impression of colour produced on the retina of the eye will be that of a colour compounded of the colours of the solutions in the three alternate apertures, diluted by the white light transmitted through the other three alternate apertures. By a proper selection of the solutions, and adjustment of the magnitude of the several apertures by means of the shutters, it will be possible to produce the exact colour of a particular star; and then the record of the solutions employed, and of the dimensions of the several apertures, will enable the exact reproduction of such colour at any future period for comparison with the then colour of the star in question. The remaining part of the apparatus is a contrivance for throwing the beam of coloured light into the telescope so as to produce, as already mentioned, the image of an artificial coloured star.

A new and very interesting microscopical object has recently been added to the available novelties for the cabinet. Mr. J. B. Dancer has made the curious discovery, that when the ash or dust which collects in the flue of a furnace is examined under the microscope with a power of 40 or 50 diameters, it is found to consist of ferruginous matter and crystallized substances, some particles transparent, others white and red. It contains also a number of curious-looking objects, which vary considerably in size and colour; the majority of these bodies are spherical, and when separated from the irregularly shaped particles forming the bulk of the dust, they become interesting objects for the microscope. Some are as perfect in form as the most carefully turned billiard balls, and have brilliant polish. Some are transparent crystal spheres; others are opaque white; many are yellow and brown, and variegated like polished agates or cornelian of different shades. There are others which look like rusty cannon balls; some of these have an aperture in them like a bombshell, and many are perforated in all directions.

To obtain these objects, the dust should be washed in a bowl, and all the lightest particles allowed to float away; the remainder consists of fragmentary, crystalline, and ferruginous substances; mixed with these are the polished balls described, which, under the microscope by a brilliant reflected light, look like little gems. To separate the spherical bodies from the irregular ones, it is only necessary to sprinkle some of this material on an inclined glass plate, and by gentle vibration the balls roll down, and can thus be collected. Mr. Dancer considers the transparent spheres to be silicates of soda or potash; the opaque white are most likely silicate of soda or potash, combined with lime and alumina; the yellow and brown are silicates coloured by iron in different proportions. The black globes are not all alike in composition; some of them are silicates coloured by carbon, others are iron balls coated externally with a silicate. Many of these rusty cannon balls are probably ferrous oxide, formed by the action of heat on the iron pyrites in the coal. There are also balls of black magnetic oxide; the perforated shells are probably ferrous sulphides. The globular form of these bodies suggests that they have been thrown off in scintillations, such as are seen during the combustion of iron in oxygen gas, and whilst in a fluid state they assume a spheroidal form. They are carried by the draught into the flue, and being of greater specific gravity than the carbonaceous matter forming the smoke, they fall before the current of air has reached the chimney. Some of the dust has been a considerable time in the flue, exposed to the intensely heated circulating flame; the reducing action of this would probably convert some of the oxide into metallic iron. Many of these balls have the appearance of reduced oxides. The movements of these objects, caused by the approach of a magnet under the stage of the microscope, are somewhat amusing, and it is at times startling to see the crystalline objects, both spherical and irregular, exhibit magnetic attraction.

That indefatigable experimentalist, M. Schönbein, has just made a further discovery respecting ozone. He finds that ordinary oxygen is without action upon the protoxide of thallium, while ozonized oxygen combines rapidly with this oxide, so as to form the peroxide of thallium, which is brown. Paper steeped in a solution of oxide of thallium and exposed to free air, would be an excellent ozonometric paper, if the carbonic acid of the air did not transform the oxide into carbonate, which passes more slowly to the state of peroxide, and blackens with difficulty under circumstances where strips of paper, iodized and starched, become coloured at the end of a few minutes in an atmosphere which contains a 1-2,000,000th part of ozone. The comparison between the two papers has at least the advantage of proving that the coloration of the iodized paper is really produced by the atmospheric ozone, and not altogether by nitrogen compounds, as believed by many.

An apparatus for measuring the different degrees of transparency of the air has been lately described by M. de la Rive, of Geneva. According to M. de la Rive, the great transparency of the air before rain is due to the presence in the air of a quantity of invisible vapour, which renders transparent the numerous germs floating in the air, to whose presence light mists are attributed.

Heat.—Gas has long been a common adjunct to English chemical laboratories, and thanks to Mr. Griffin, the scientific man here is provided with a multiplicity of gas furnaces, for obtaining all kinds of results, from the slow evaporation of a pint of water to the fusion of ten pounds of iron. In Paris, however, gas furnaces are only just coming into vogue, and in their usual happy way our continental confrères are rediscovering many forms of apparatus which are well known here. At a recent meeting of the Academy, M. Debray described two forms of apparatus for producing very elevated temperatures by means of common gas mixed with air. The first was said to be a form of M. Schlösing, modified by M. Wisnegg; the second, that of M. Perrot. If a certain number of Bunsen burners be united together so as to form one single jet of flame, without, however, complete incorporation, the heating power is most remarkable, provided a sufficiently energetic and swift draught is given to it. The form of the furnace must also be varied, and the draught regulated according to circumstances. With an apparatus burning 70 cubic feet per hour, under a pressure of two or three inches of water, and without any draught but that obtained by a sheet-iron pipe 6½ feet high, M. Debray was able, in fifteen minutes, to melt 1·48 lb. of silver. It only takes half-an-hour at most, when the operation is at full work, to melt and cast upwards of 2 lbs. of copper into a bar. Lastly, M. Debray melted several specimens of grey and white iron. A pound of a variety of cast-iron, which was considered very difficult to melt, was run in thirty minutes; another piece, weighing 1½ lb., was melted in an hour or so. During the operation, the crucible can be examined in the interior by the aid of a mirror or a bucket of water, which can receive the metal in case of accident. There appear to be more points of novelty in this furnace than in most of the French adaptations, but it is very similar to Gore's Gas Furnace in its effects, and not unlike it in principle.

The evaporation of large masses of liquids, simple as it may appear on the small scale, is a formidable operation when many tons weight of liquid have to be dealt with. M. E. Parion, at Wardrecques, St. Omer, has invented a new process for the renewal of the surface of the liquid exposed in the state of fine division in contact with the air, or to the products of the combustion, according as the evaporation should take place with or without the aid of artificial heat. When the evaporation takes place by the aid of the temperature of

the air alone, the liquids are divided into a small shower exposed to the wind and sun. By maintaining them in this state we obtain in a small space, and one easy to cover when necessary, the same results as the concentrating basins and the graduating buildings give at great cost and with a vast extent of land. In the case of the employment of artificial heat, the waste heat from chimneys of factories is utilized in preference, and in the absence of this any source of heat is employed if the products obtained have a sufficient value to pay the expenses.

The artificial production of ice is a problem which has attracted considerable attention of late years, and amongst the inventors of practically useful pieces of apparatus, M. Carré is one of the most successful. He has now described some new machinery for the production of cold, based upon the rapid evaporation of water aided by an air-pump and sulphuric acid. The apparatus would be difficult to describe without the aid of diagrams, but we may state that his air-pump is very cheap, and has worked without repair for eighteen months; the receivers for acid are formed of an alloy of lead and antimony, which will resist for a number of years the attack of sulphuric acid. The pump is made of copper, and the sides are constantly coated with oil. The valves are moved mechanically. The apparatus retains a vacuum for many months, and one kilogramme of acid at 66° produces two or three kilogrammes of ice. Freezing commences three or four minutes after exhausting.

Electricity.—The theory of Grove's gas battery has occasioned perhaps more discussion than that of any other instrument of the electromotor class. When it was first described by the learned inventor, M. Schönbein made certain objections to Mr. Grove's explanation of its action; but these did not attract the attention they deserved at the time. M. J. M. Gaugain has now arrived at the same conclusion as Schönbein, using a different mode of investigation. He only worked with one element at a time, and instead of measuring the intensity of the current, he measured the electro-motive force directly by the method of opposition. In this manner the influence of the modifications which were successively introduced into the arrangement of the couple could be numerically estimated. The author explains how it is that Mr. Grove arrived at a different result to his own. Mr. Grove considered it indispensable that each of the platinum electrodes should be simultaneously in contact with one of the gases and the liquid beneath. M. Gaugain finds, however, that when the platinum wires are immersed completely in the liquid, and therefore out of contact with the gas, the electro-motive force is exactly the same as when arranged according to Mr. Grove's principle. It follows therefore that the action of the platinum only extends to the dissolved gas, and that

the vessels containing oxygen and hydrogen serve no other purpose than that of keeping the water over which they stand fully saturated with gas. The author has found that the electro-motive force of the gas battery is not modified by replacing the oxygen vessel by one containing carbonic acid, and the general conclusion at which he arrives is that the electro-motive force put into play in Grove's battery is due exclusively, or almost so, to the affinity exerted between the oxygen of the water and the hydrogen condensed by the platinum electrode.

A new force will have to be introduced into chemical physics—that of capillarity. We notice it under the present heading, inasmuch as the effects appear to be more nearly allied to those of electricity than to any other force. M. Becquerel, sen., has been experimenting for some time on what he now terms capillary chemistry. He finds that chemical decompositions take place under the influence of capillarity, and he thinks he has proved that these curious phenomena are produced under the triple influence of affinity, capillarity, and electricity. To demonstrate the intervention of electricity, M. Becquerel has made the following experiment: he immerses a *split* bell-glass, containing nitrate of copper, in a second glass, containing a solution of monosulphide of potassium; then he dips the two extremities of a silver wire, one into the nitrate and the other into the monosulphide. A constant electric current is formed, and the deposit of silver is made, not in the capillary slit, but on the iron. When the wire is removed, the deposit is formed in the slit, and on the edges along the sides of the split bell-glass. The capillary action is as powerful as an electrical action. M. Becquerel has since improved his experiments; for the split bell-glass he substitutes prisms of crystal pierced with a small hole; the slit or fissure is replaced by plates of glass with edges in contact, or even by sand, and he has thus obtained effects of silvering, gilding, platinizing, and very remarkable deposits of gold, silver, nickel, and cobalt. At one of the meetings of the French Academy he exhibited several specimens of metals reduced and precipitated by capillary action. In order to answer the objection that these phenomena of reduction or precipitation might be attributed to the action of the alkalies of the split glass tube, he has employed polished plates of rock-crystal pressed one against the other, so as to leave only a very small interval; he has thus obtained perfect reduction of several metals. The interval between the plates must be varied according to the different metals. For the reduction of gold, for example, the space between the plates must be less than that for copper.

In an investigation on the inductive current of the Ruhmkorff coil, M. Blaserna, Professor of the University of Palermo, has arrived at the following conclusions respecting the passage of

induction currents:—1. The time elapsed between the closing or the rupture of the circuit and the apparition of the current of induction, or the attraction of the armature for the bobbin of induction, is inappreciable, being less than the fiftieth part of a second. 2. The current of induction, feeble at its commencement, increases little by little, then diminishes, and is extinguished in an interval difficult to determine.

All who have experimented much at electrotyping have been troubled by a defect in the electro deposition of copper, which is sometimes seriously injurious, *viz.* its brittleness. M. Bouillet has found that a very small quantity of gelatin dissolved in the bath gives a copper of nearly equal malleability to rolled copper, whereas the pure bath only gives a porous, defective metal-like cast copper. The relative specific gravities of copper in different states are: cast copper, 8·78; laminated copper, 8·95; galvanic copper, 8·86.

Gutta-percha moulds are exclusively used by the large firm of Christophle and Co., Paris. They are applied either cold by pressure with a lever, or by the hand. The mould is rendered conductive either by blacklead, or silver, reduced from the nitrate by nascent hydrogen.

10. ZOOLOGY, ANIMAL PHYSIOLOGY, AND MORPHOLOGY.

Morphology.

Occluding Apparatus of the Tracheæ in Insects.—Burmeister was the first who showed that insects have a means of closing up their tracheæ so as to prevent all communication with the exterior. The subject has since been studied by Herman and Leonard Landois, and by W. Thelen. They have found an apparatus adapted for this purpose in all insects, consisting of an imperfect chitinous ring (a muscle) ligament, and sometimes an accessory lever. Such an apparatus is placed in each main tracheal stem below, and independent of the stigma. Dr. H. Landois and W. Thelen have recently published a joint memoir on the subject. The complexity of development of this apparatus they show varies very much in different orders of insects, and in the Neuroptera is reduced to a minimum. In many cases it is so much developed, as to constitute a sort of larynx, and as such may serve as a vocal organ. The solid chitinous parts are always connected in such a way, that in a state of quiescence the tracheal tube remains open, and gives free entrance and exit to the air through the stigma. Muscular action is necessary to close the apparatus. This is effected in all cases by

a single muscle, which differs in different species in the greater or less number of its fibrillæ. Dr. Landois and his colleague point out that a closing apparatus of some kind, to the tracheæ, must be required in all insects, inasmuch as the movement of the air in the tracheæ can only be effected by the movements of the body or muscles, &c., which, were the exit of the air at all times free, would have as great a tendency to expel it through the stigmata, or even a greater, than to force it onwards into the minute ramifications of the tracheal system. The memoir, which appears in Kölliker's 'Zeitschrift,' is most beautifully illustrated, and contains descriptions of the "occluding apparatus" of more than twenty insects of various orders.

Relative Size of Terebratulæ.—The largest living species of Terebratula has been lately noticed by Mr. Davidson, who devotes himself to the study of the Lamp-shells. Rear-Admiral Sulivan dredged the specimen in question in the outer harbour of Port William, in the Falkland Islands, and has submitted it to Mr. Davidson, who considers it identical with the *Waldheinia venosa* of Solander. It is a remarkable thing that the largest Terebratulæ known occur in the crag strata, exceeding this species in length by an inch (*W. venosa* has been found 3 inches 2 lines in length, and *T. grandis* 4 inches 2 lines). Very large species occur in Cretaceous beds, and still larger in Jurassic strata, but not so large as the Tertiary or the Recent species. In the Triassic and Palæozoic periods only few and diminutive species occur. It is worth noticing that the very large species of all periods, whether belonging to the short or to the long-looped sub-genus, have a very marked similarity in the outline and form of their shells.

A new Annelid from Dieppe.—Dr. Richard Greeff has found a new species of the annelid-genus *Sphærodorum* in the oyster-beds at Dieppe. *Sphærodorum* is the name given by Œrsted to one of the strangest of Chœtopodous worms. The little creature does not exhibit very well-developed feet-appendages, or a high form of cephalization; but it is remarkable for the large globular capsules, containing coiled-up, worm-like bodies, which are disposed in series on the rings of its body. Professor Kölliker has shown that it is most probable that these capsular bodies are large glands. The species known to Œrsted had only two of these warty processes on each body-ring, but that described by Dr. Greeff has ten. It differs, moreover, very greatly in size from the first known species, which is described as having a "serpentiform" body two inches in length, while Dr. Greeff's species is a stumpy little creature only two millimetres long. It is most probable that the new species is a very immature form

The European Hyalonema.—The Glass-Rope controversy is not yet ended, for while Professor Ehrenberg has given up his belief

that *Hyalonema* is an artificial Japanese product, and Professor Max Schultz seems to gain most support in regarding them as the joint productions of a sponge and a polyp, Professor J. V. Barboza du Bocage is doing his best to prove that a European *Hyalonema* is found off the coast of Portugal. In two letters to Dr. Gray, of the British Museum, he has given the names of persons (mostly fishermen) who have obtained altogether twelve specimens of *Hyalonema* for him, when engaged in the shark-fishery. He considers there can have been no fraud, as vessels do not sail from the part of the Portuguese coast in question to Japan. Moreover, he says that the fishing people and others know them as "chicote de mar," that is to say, "sea-whips." Altogether, the evidence seems to be in favour of the reality of *Hyalonema Lusitanicum*, but its occurrence must be still regarded as a very strange and anomalous fact. Perhaps, before long, the distribution of *Hyalonema* may be shown to be very much wider than was supposed, and then the strangeness of a genus having representatives only in Japan and Portugal will disappear.

Physiology.

Regeneration of Limbs.—M. Philipeaux has been of late favouring the French Academy with various communications on the regeneration of limbs or organs of various animals, after amputation or excision. He has made a large series of experiments on the re-development of the spleen, and has found in all cases that it is not regenerated unless a certain portion has been left as a starting point for the new growth. So, too, with the fore-limbs of the larger Newt; when amputated so as to leave the basal portion intact, the limb was rapidly and entirely re-formed, but when the limb was removed with the scapula, nothing was produced but a cicatrix. M. Philipeaux has now made similar experiments on some of the Mexican Axolotls, which were hatched in the Jardin des Plantes last year. The experiments were made on ten individuals, five of which had the left anterior limb entirely amputated, and five the right anterior limb only partially so—that is to say, leaving the head of the humerus and the scapula. In all five of the first series there is now a simple cicatrix; in all five of the second series, the whole limb has been completely regenerated.

Muscular Contractibility.—M. Rouget has been studying muscular contraction, and has taken as his starting point the stem of the *Vorticella*. He repeats the well-known observations on that structure, and remarks that the state of repose in the *Vorticella*-stem in its contracted condition is shown principally by its assuming this state when freed in any way from the bell-like body it

supports.* M. Rouget then asks, "Is this peculiar to the *Vorticella*-stem, or is it the condition of muscular contraction in all animals?" The matter is worth consideration certainly, and has been considered by many physiologists, who do not, however, all assume the identity of Vorticella-stems and muscular fibres. M. Rouget intends shortly to prove—1st, that a recent hypothesis, according to which permanent contraction is essentially constituted by a series of successive shocks or vibrations, is in absolute contradiction to well-observed facts; 2nd, that a tendency towards extreme contraction is a property inherent in living muscular fibre, a necessary consequence of its structure and elasticity; 3rd, that during life this tendency to contraction is combated by a cause of extension which predominates during the repose of the muscle, is developed in the exchange of the nutritive materials, increases with the activity of their access, diminishes or becomes extinguished by their exhaustion, and may be momentarily suspended by all the excitants of muscular contractility — nervous action, heat, the electric shock, &c.

Do the Hare and Rabbit breed together?—Dr. Pigeaux has been making some inquiries into this matter, and believes that never, or quite accidentally and rarely, does the hare breed with the rabbit. The so-called "Léporides" are true rabbits, and not hybrids at all. The belief in the existence of such a hybrid was prevalent among the ancients, and indeed is so among some moderns, but is merely due to the existence of varieties of the rabbit having somewhat the aspect of hares. By keeping hares and rabbits in confinement, and carefully managing them, hybrids may be obtained, and a case is quoted by Dr. Pigeaux. It does not appear, however, that the mule was fertile, and it was, moreover, an unsatisfactory creature in other ways, having from a culinary point of view neither the advantages of the hare's flavour nor the rabbit's whiteness.

* A better proof than the one given by M. Rouget is that *Vorticella* (in common with many similar forms, and with the contractile parts of others) extends *slowly* and contracts *rapidly*. We know well that if we wish to extend a spiral spring, it is a slow process compared with its contraction.—The Editors.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT DUNDEE, September, 1867.

The meeting which has just closed has rivalled in interest and number of visitors any of the previous northern gatherings, with the exception of the Aberdeen meeting, which was perhaps exceptionally large, owing to the Presidency of the late Prince Consort. Last year it was our duty to draw attention to the very high charges for lodgings made by the inhabitants of Nottingham: we are glad to say that no complaints of this character can fairly be made against Dundee. The attendance in the Sections has been better than usual, and the earnestness of those who went for strictly scientific purposes was shown by the number of papers announced in each morning's journal, and by the length and interest of the discussions which the more important of these papers elicited.

The value of these autumnal meetings of the Parliament of Science becomes every year more and more apparent. The chief advantage, however, does not arise from a diligent attendance at the Sections, but from those impalpable influences which result from a lounge in the reception room—a picnic or excursion to some place of note in the neighbourhood—a look-in at the B.'s, the Red Lions, or the Eastern Club. Men, who before only knew each other in the pages of a scientific journal, here meet in friendly companionship, and the keen scientific antagonist becomes a personal friend for life. A controversy which has been dragging on for years is settled by ten minutes' personal explanation; and opponents who were rapidly approaching the orthodox scientific intensity of hatred, carry away from such a meeting mutual forbearance and respect. These are precious results, and if the Sections are of no other use, they have the inestimable advantage of drawing men of kindred pursuits together from all parts of the kingdom, and giving them an excuse for a week's holiday under the convenient pretext of attending a scientific meeting.

At the General Meeting which took place on Wednesday, the 4th of September, the usual reports were read. One of these, the report of the committee appointed by the Council of the Association to consider the best means for promoting scientific education in schools, deserves more than a passing notice. The report, after pointing out that there is already a general recognition of science as an element in liberal education, and stating that general educa-

tion in schools ought to include some training in science, went on to refer to the difficulties in the way of introducing science into schools,—difficulties which the committee, however, considered easily surmountable. With a view to the furtherance of the scheme, the committee made the following suggestions:—

1. That in all schools natural science be one of the subjects to be taught, and that in every public school at least one natural science master be appointed for that purpose.

2. That at least three hours a week be devoted to such scientific instruction.

3. That natural science should be placed on an equal footing with mathematics and modern languages in effecting promotions, and in winning honours and prizes.

4. That some knowledge of arithmetic should be required for admission into all public schools.

5. That the universities and colleges be invited to assist in the introduction of scientific education by making natural science a subject of examination, either at matriculation, or at an early period of a university career.

6. That the importance of appointing lecturers in science, and offering entrance scholarships, exhibitions, and fellowships for the encouragement of scientific attainments, be represented to the authorities of the colleges.

Usually the great feature of the meeting has been the President's address. This opportunity is generally taken for giving a comprehensive review of the progress of the various branches of science during the past year, and not unfrequently speculations are indulged in, or old truths are put forward in so novel a light as to cause the address itself to be not the least valuable scientific memoir which the year has produced. Such was the magnificent inaugural speech delivered by Mr. Grove, the late President, whose key-word—continuity, introduced a subject of dissertation worthy of the author of the "Correlation of Forces." This year the members of the Association have no such fruitful harvest of speculation to look back upon. The address was short, and was delivered by his Grace the Duke of Buccleuch, without notes. Its delivery had no pretension to eloquence, and for the most part it consisted of apologies for the speaker's shortcomings. To quote one of the local papers—

"The address was an utter, hopeless, complete failure, producing a blank sense of dismal disappointment, deepening into one of painful pity for a man who had suffered himself to be placed in such a false position; and after a few minutes, though it was a Duke that was speaking, it was impossible for those who wished to help his Grace to prompt anything which could be construed into general applause." . . . . "The props of pride of place and

confidence in self broke down one after the other, and the unfortunate speaker went on stumbling unsupported through confused commonplace and feeble platitude."

Physical Science. (Section A.)

The proceedings in this Section were opened by an introductory address, delivered by the President of the Section, Sir Wm. Thomson, F.R.S. It was very short, and was delivered mainly to give the speaker an opportunity of adding his tribute to the memory of the great man whose loss all cultivators of physical science deplore. He said he should not attempt to give any account of Faraday's discoveries and philosophy—*those* live for us still. He wished he could put in words something of the image which the name of Faraday always suggested to his mind. Kindliness and unselfishness of disposition; clearness and singleness of purpose; brevity, simplicity and directness; sympathy with his audience or his friend; perfect natural tact and good taste; thorough cultivation—all these he had, each to a rare degree; and their influence pervaded his language and manner, whether in conversation or lecture. But all these combined made only a part of Faraday's charm. He had an indescribable quality of quickness and life. Something of the light of his genius irradiated all with a certain bright intelligence, and gave a singular charm to his manner, which was felt by every one, from the deepest philosopher to the simplest child who ever had the privilege of seeing him in his home—the Royal Institution. That light is now gone from us. While thankful for having seen and felt it, we cannot but mourn our loss, and feel that, whatever good things may yet be in store for us, *that* light we can never see again.

It will be impossible to notice any but the more important of the papers read before the Sections, in the limited space which can be devoted to this subject. The report of the Lunar Committee was first brought forward by Mr. Glaisher and Mr. Birt. The objects originally contemplated in the appointment of the Lunar Committee were:—

1. The registration of craters and visible objects on the moon's surface in forms prepared by the Committee.

2. The construction of an outline map of four times the area of Beer and Mädler's, according to the plan proposed by Mr. Birt.

3. The conducting correspondence on the subjects.

The report gave a detailed account of the manner in which these objects had been carried out. Some attention was devoted to the alteration which is supposed to have taken place in the crater Linné. Mr. Birt said that there was an opinion that this crater had been filled up by a volcanic eruption.

Prof. J. Clerk Maxwell read a paper on a real image stereoscope. In this instrument a frame containing a large single lens is placed in front of the pictures, and the observer stands about two feet from the instrument; he then sees, just in front of the lens, a real and inverted image of each of the two pictures, the union of which forms the appearance of a solid figure in the air between himself and the apparatus.

Dr. Balfour Stewart, Superintendent of Kew Observatory, read a paper "On the Behaviour of the Aneroid Barometer at different Pressures." Experiments had lately been made with the view of ascertaining to what extent an Aneroid may be considered a reliable instrument when exposed to considerable changes of pressure, such as occur in mountain districts. By means of an air-pump, the Aneroids, when placed in a receiver, might be subjected to any pressure. A method of tapping the Aneroids had also been devised, and by this means the experiments as to the deviation of the results given by these instruments were conducted with comparative ease, and with the greatest accuracy.

The next day Mr. Glaisher gave a report on luminous meteors, which was followed by an interesting discussion in which Professor A. Herschel said that the connection between comets and meteors had this year been established without doubt. He would not say that every shooting star was a comet. They were more likely the dissipated parts of comets—probably comets torn into shreds by the sun's attraction drawing them into space.

Some papers by Sir David Brewster on various optical subjects followed: one of these gave an account of experiments which, Sir David remarked, were sufficient to establish the almost incredible truth, that the colours of the soap bubble are not produced by different thicknesses of the film itself, but by the secretion from it of a new substance flowing over the film, expanding under the influence of gravity and molecular forces into coloured groups of various shapes, and returning spontaneously, when not returned forcibly, into the parent film.

The President, Sir William Thomson, next read an important paper on a new electrical machine founded on induction and convection. The principle of the machine was that of the "Successful Merchant," who commenced his life with the capital of ½*d.*, and after a month's persevering industry, realized the handsome sum of £1, and continued to go on increasing his capital at a compound rate of interest. The object of the instrument referred to was not indeed to increase money, but electricity, and that increase was at a compound rate. Precisely in conformity to the law which applied to compound interest and the increase of the

successful merchant's capital was the increase of electricity by this machine. Given the smallest quantity of electricity, and the instrument increased it at the rate of compound interest, and this increase went on at a perfectly uniform rate. But just as the capitalist finds that he cannot always go on getting higher and higher interest for his money, but must ultimately, perhaps, be content with $4\frac{1}{2}$ per cent. instead of 5, so was it to some extent with this machine. When a very high charge was reached, the increase of the quantity of available electricity was not so great, owing to sparks passing in various parts of the machine, preventing the operator from retaining the full quantity of electricity which was got by it. There was great necessity for an easy-going electric machine, and that now shown fulfilled this condition.

Two papers by Mr. Ladd were next read on some new magneto-electric machines; and Mr. Claudet brought forward his discoveries in binocular vision, and his self-acting focus-regulator.

The greater part of the proceedings in this Section on Monday consisted of a paper and discussion on the storm-warnings—their importance and practicability; and a resolution was carried unanimously that this Section apply to the Council of the British Association to make a communication to Her Majesty's Board of Trade, urging them to institute arrangements for carrying storm-signals to be resumed. Colonel Sykes brought forward ample evidence to show that these warnings should be resumed. Mr. John Don, the President of the Dundee Chamber of Commerce, also spoke in favour of their resumption. Mr. D. Milne Holme, of Wedderburn, Dr. Balfour Stuart, the Duke of Buccleuch, Sir John Ogilvy, and others, took part in the discussion.

The proceedings opened on Tuesday with some meteorological papers, which were followed by several papers on electrical subjects. The chief subject of interest was the alleged correspondence between Newton and Pascal. Two papers were read bearing on the question; one by Professor Hirst, stating some of the circumstances attending the production of the correspondence before the Academy of France, and indicating grounds for receiving with caution this remarkable claim that has been put forward by the Academy—a claim which if established would transfer to Pascal much of the glory that has been associated with the name of Newton. Sir David Brewster also read a short paper, pointing out that the correspondence was a forgery, almost unparalleled in literary or scientific history. M. N. de Khanikof, a celebrated French Orientalist, made an interesting speech on the MSS. of Pascal, and spoke highly of M. Chasles, who had brought the correspondence referred to before the notice of the scientific public.

Section A was the only one which sat on Wednesday, when

three papers were read. The first was a very important one, by Professor Wheatstone, "On a New Telegraphic Thermometer." The apparatus consists of two distinct instruments, connected only by telegraphic wires. The first is called the questioner, the second the responder. With this apparatus the indications are not spontaneously conveyed to the observer, but they must be asked for, and whenever this is done the indications will be immediately transmitted to him, however frequently the question is put. The uses to which this Telegraphic Thermometer may be applied, are, among others, the following:—the responder may be placed at the top of a high mountain and left there for any length of time, while its indications may be read at any station below. Thus, if there should be no insuperable difficulties in placing the wires, the indications of a thermometer placed at the summit of Mont Blanc may be read as often as required at Chamouni. A year's hourly observations under such circumstances would no doubt be of great value. If it be required to ascertain during a long-continued period the temperature of the earth at different depths below its surface, several responders may be permanently buried at the required depths. It will not be requisite to have separate questioners for each, as the same may be applied successively to all the different wires. The responder, made perfectly water-tight, in which there would be no difficulty, might be lowered to the bottom of the sea, and its indications read at any intervals during its descent. In the present mode of making marine thermometric observations, it is necessary that the thermometer should be raised whenever a fresh observation is required to be made.

The next paper was one by Major Tennant, regarding the steps that are being taken by the Indian Government to ensure extensive and correct observations of the total solar eclipse of 1868. This will be seen to great advantage in India, and the totality will last almost the maximum possible time—about five-and-a-half minutes. Arrangements will be made to obtain as many photographs as possible of the phenomena of totality, and spectrum-observations will also be made of the corona.

Chemical Science. (Section B.)

The President of this Section, Professor Thomas Anderson, opened the proceedings on Thursday, the 5th of September, by an address, in which he passed in review the new theories which have lately been introduced into Chemistry, which have had the effect of unsettling the views formerly entertained without as yet introducing anything conclusive in their place. Dalton's atomic theory has proved itself no longer sufficient; it has done its work, and in the

future is less likely to act as an assistance than as a hindrance to progress. Sir B. Brodie's theory is one from which the idea of atoms is excluded, although it is by no means incompatible with them. It is a system which involves a very great amount of hypothesis, for the assumption of the compound nature of certain of the elements is rendered necessary by Sir Benjamin's fundamental hypothesis. The question must at best be considered as still *sub judice*, and the method is not likely to meet with general acceptance until it is supported by a much larger body of facts than those we at present possess.

The most important paper read this day was one "On the Decay of Stone, its Cause and Prevention," by J. Spiller. The author has arrived at the conclusion that the corrosive action of sulphurous and sulphuric acids in the atmosphere, resulting from the combustion of coal-fuel, operates, in large towns especially, in a very destructive manner upon dolomite and the numerous class of limestones commonly employed in our public buildings; this chemical action, aided no doubt by the simultaneous attack of carbonic acid and moisture, and in the winter season further supplemented by the disintegrating effects of frost, furnishes a sufficient explanation of all the facts observed. The best coal and coke contain one per cent. of sulphur, equal to 70 lbs. of oil of vitriol for every ton of coal burnt. This is the origin of the sulphates invariably present in the loosened crust of decayed stones, whether of calcareous or magnesian character. As a remedy for the decay of stone, Mr. Spiller proposes the application to the cleaned surfaces of the stone of an aqueous solution of superphosphate of lime,—a salt remarkable for its action in hardening the surfaces of chalk, Caen stone, or other calcareous building stone to which it may be applied, either by brushing or immersion, and which acts upon the carbonate of lime in the stone, giving rise to the formation of crystallized diphosphate of lime.

The author brought forward some interesting results to record in connection with the treatment of Portland stone, which serve to illustrate the increased hardness and strength, and the diminished rate and capacity of water-absorption, attending the employment of the superphosphate. The cost of materials employed in the treatment of stone according to this plan is very trifling, and bears but a small proportion to the cost of labour necessarily expended upon the cleaning and preliminary preparation of the stone before the solution can be applied. One gallon of solution will cover about 300 feet superficial, when two coatings are applied upon Caen or Portland stone. The superphosphate employed must not contain any appreciable amount of sulphuric acid, and the specific gravity of the solution, when diluted for use, should be about 1,100.

Mr. Walter Weldon read a paper "On the Regeneration of Oxide of Manganese in Chlorine Stills."

The author stated that the essential features of the process consisted, firstly, in the use of an *artificial* oxide of manganese, capable of liberating from a given quantity of hydrochloric acid about twice as much chlorine as could practically be obtained therefrom by means of a 70 per cent. native oxide; and, secondly, in a simple method of reproducing the artificial oxide from the "still-liquor." This recovery of the artificial oxide might be performed in the stills themselves, so that a charge of manganese, once placed in a still, might always remain therein, continually generating chlorine; and not only never requiring removal, but never undergoing diminution of properties, nor suffering loss by waste.

On Friday the following papers were read, "On the Present Use of Lichens as Dye Stuffs," by Lauder Lindsay; "On the Determination of Nitrogenous Organic Matters in Water," by Dougald Campbell. The latter paper proved that the method of estimating the amount of nitrogenous matter in water proposed by Messrs. Wanklyn, Chapman, and Smith, was erroneous. "A description of a new Ether Anemometer," by Alfred E. Fletcher, Government Inspector of Alkali Works for the western districts. The construction of this apparatus is based on the fact that a current of air passing across the open end of a straight tube causes a partial vacuum in it. An application of this principle is seen in a small toy in common use, in which a liquid is made to ascend several inches in a vertical tube, by blowing through another tube across its open end. It rises by virtue of the partial vacuum caused by the current of air which crosses it. By the aid of this Anemometer the speed of any current of air in flues or chimneys can be measured by simply boring a hole one inch diameter through the brickwork, and inserting two tubes, one with a bent, the other with a plain straight end as already described, and making the necessary observation of the floats; and in this operation neither soot, heat, nor corrosive vapours can prove any hindrance. So sensitive is the apparatus that on a windy day the effect of each successive gust of wind is observable, as it causes variations in the draught of the chimney. The instrument may be used as a wind gauge by fixing through the roof of an observatory a small vertical pipe, presenting a plain open end to the wind. The lower end of this pipe brought down into the observatory and connected with the ether manometer would communicate the varying pressures due to the varying speed of the wind.

On "An Apparatus for indicating the Presence and Amount of Fire Damp in Mines," by George F. Ansell. The idea embodied in the apparatus was founded on the law of diffusion announced by

Mr. Graham, that gases diffuse in the inverse proportion to the square root of their densities, or, more popularly, that light gases diffuse more rapidly than heavy ones. Mr. Ansell showed, by experiment, that when a tube closed at one end by plaster of Paris, was filled with common coal gas, the lighter part of the compound was rapidly diffused through the plaster, as was at once seen by the yellow flame and slight explosion which ensued on bringing a lighted match close to the closed end. Hence, Mr. Ansell said, his proposition. In a pit the case is the reverse of that of the tube. There the gas is ready to escape into the galleries, and the apparatus must therefore be modified to suit the varying circumstances. The essential parts of the apparatus may be described as consisting of an alarm bell and a telegraph needle—the former being rung and the latter deflected by an electric current, which was set in motion by the action of the dangerous gas. The means by which this was effected consisted of an iron cup, on which was fixed a disc of white Sicilian marble, standing on a U-tube, which contained a quantity of mercury. The marble here represented the plaster which closed the end of the tube in the first experiment, and through it the dangerous gas was diffused. As it did so, the mercury was pressed up into the other extremity of the tube, completed the previously broken circuit, and an alarm was given by the ringing of the bell and the deflection of the needle.

"Notes of Analyses of Gold Coins of Columbia, New Grenada, Chili, and Bolivia, with some Account of the Operations of Gold Mining in Nova Scotia," by George Lawson, Ph. D. The first part of this paper was principally devoted to the history and description of the gold coinage of the above-mentioned countries, with physical and chemical analyses. Some information was then given respecting the composition of the native gold of coining countries, and a useful list was appended, showing the principal gold coins of various countries, with their weights, fineness, and values, and a synopsis of the results of assays and analyses of native gold from the chief mines of the world. The author then proceeded to make some remarks on the process lately invented by Mr. Crookes, by which sodium amalgam is added to the mercury. He stated that he had experimented to a considerable extent on the effects of sodium amalgam, and found it to exert a very remarkable power in facilitating the absorption of gold by mercury, quite independently of any action of the soda necessarily formed during the operation. The coating of the copper surfaces with mercury alone had been found practically to be a troublesome and tedious operation; but the use of a little sodium amalgam added to the mercury enabled the coating to be given by a simple rubbing without any waste of time. Some illustrations of the advantages of Mr. Crookes's process were then given. It was stated that in some experiments undertaken in

conjunction with Dr. Krackowizer, formerly of Vienna, at the Lake Major Mines, a quantity of pyrites collected from the tailings (after passing through the mill in the usual way) was re-subjected to the action of mercury, to which sodium had now been added, and by this means the waste material from which all the gold was supposed to have been abstracted, yielded a fresh supply at the rate of five ounces of gold per ton of pyrites.

In the discussion which followed the reading of this paper, Mr. Crookes said that there was one thing which ought especially to be attended to in employing this process, and that was to avoid introducing too much sodium. Every failure which had come under his notice had arisen from ignorance of the action which the sodium was intended to exert on the mercury. If too much were added it exerted a chemical action, reduced the iron, copper, lead, &c., which might be present in the ore, and loaded the mercury with base metals, destroying its power of wetting gold, and causing it rapidly to flour away when triturated in a stream of water. If, however, only a trace of sodium were introduced (say 1 in 10,000 or 1 in 100,000), it acted physically rather than chemically; it put the mercury into a highly electro-positive state, and by greatly widening the electric interval between this metal and gold, increased their mutual affinity.

A paper was afterwards read "On certain new Processes in Photography," by J. Spiller. He first described what is known as the Woodbury-type process, which is based on the insolubility of chromo-gelatin after exposure to light, and upon the subsequent action of water upon a sensitive film, which has been in different degrees influenced by insolation under an ordinary photographic negative. The depths of tint in the original are represented by variations in the thickness of the film of gelatin left unacted upon by water, and this dried may then be used as a matrix to produce a corresponding series of depressions upon a surface of lead or type-metal by the aid of a powerful hydraulic press. The blocks so produced serve for printing off a great number of proofs when they are liberally "inked" with warm gelatin, highly charged with Frankfort black or other suitable pigment, and pressed down upon a smooth sheet of paper until the excess of ink is forced out on all four sides of the block, and so removed from the space constituting the picture, which, when set, is, lastly, protected with a varnish of collodion. A glass plate may be used instead of paper to receive the ink, and this, backed with another (opal) glass, gives an excellent result, suitable for a variety of ornamental purposes.

Mr. Woodbury has lately perfected a modification of his process, which is applicable to the representation in high relief of microscopic objects. The method consists in spreading a warm

solution of gelatin, containing a little sugar and chromate of potash, over a glass plate previously coated with collodion. The film sets on cooling, and is then placed in contact with an ordinary photographic negative of the microscopic objects to be delineated, exposed to light, submitted as before to the action of water, and the soluble portions washed away. When the surface-moisture has evaporated, a mixture of plaster of Paris, containing a small proportion of alum, is poured over the relief to the thickness of half-an-inch, and left to set. When dry it will be found, owing to the alum in the plaster having hardened the surface of the gelatin directly on coming in contact therewith, to leave the gelatin easily, without any fear of adhesion. To give a finished appearance to the resulting casts, this intaglio, when dry, may be placed in a lathe, and a suitable border turned on it, which will be represented in the resulting proofs by a raised border, similar to what is seen on medallions or plaster casts. The name of the object may also be neatly engraved on the intaglio, to appear in raised characters on the reliefs. This intaglio should then be well waxed to fill up the pores, and is ready for taking any number of impressions in plaster; or a better plan is to take one in plaster, and having smoothed away any defects to mould a reverse in sulphur, which will give a greater number of fine impressions.

The author finally alluded to the subject of photolithography, as used in the photographic establishment of the War Department, at Woolwich.

Mr. Crookes then described his "New Polarizing Photometer."

Geology. (Section C.)

Although a large number of valuable papers were communicated to the Geological Section of the British Association at Dundee, there were few which, from their originality or largeness of conception, were calculated to leave a lasting impression on the minds of those present. There was no announcement of a new system of rocks—of a new theory of metamorphism—or of the annihilation of some generally received and cherished doctrine. The papers were on the whole fragmentary treatises on matters of detail—bricks and stones intended to occupy their special nitches in the temple of Science—and as such not without their value. Nor can we shut our eyes to the fact, that such must be the general character of the investigations of future geologists. Far be it from us to assert that this branch of Science is incapable of presenting new facts, and of giving rise to new speculations, regarding the past history of the globe and its inhabitants; but we are now sufficiently well acquainted with the order of succession of the groups and

formations of rocks to feel satisfied that there is no room for the establishment of any new system of strata, such as the Silurian, the Carboniferous, or the Triassic; nor can we suppose that future discovery will materially alter our views regarding the order of succession of life on the globe.

The business of the Section was opened by a very instructive address from the President, Mr. A. Geikie, F.R.S., who, instead of drawing up a discursive essay on the science of Geology in general, limited his remarks—as we think wisely—to one special branch, to which his own attention has been specially directed. The subject chosen had reference to the successive periods in Geological time, during which there are evidences of volcanic activity in the British Islands. In this address the author showed "that from the massive feldspathic lavas and ashes of the Lower Silurian rocks, up to the great basaltic plateaux of Miocene age, most of our geological formations contain somewhere evidences of contemporaneous volcanic activity." Commencing with the sheets of felstone and tuff of the Lower Silurian period in Wales, which were first described by Sedgwick and Murchison, and have been mapped and described in great detail by the Government Geological Surveyors, the author gave a graphic sketch of the successive outbursts of volcanic activity during the Upper Silurian, Old Red Sandstone, Carboniferous, Permian, Triassic, and Tertiary Periods. To the Miocene stage Mr. Geikie refers the great trappean masses of Skye, the inner Hebrides, and the north of Ireland, as well as the dykes which traverse some of the rocks of the south-west of Scotland and the north of England. This view, which is in opposition to that of the late Professor E. Forbes, who referred them to the Oolitic period, Mr. Geikie founds on the fact, amongst others, that in Mull, masses of porphyritic and trachyte-like rocks, with a united thickness of over 3,000 feet, overlie beds with plants of Miocene species. Before passing on from the address, we are desirous of calling the author's attention to two points with reference to the age of certain outbursts of trap in England. Mr. Geikie may not be aware that in Leicestershire there is an instance of an outflow of trap which in all probability is referable to the Permian period. This rock occurs as a sheet of greenstone overlying unconformably the Coal-measures, and in turn overspread by Triassic strata, which are in no way affected by it. As it seems to have been erupted at a period between the Carboniferous and Triassic formations, it may be fairly referred to the Permian age, and is perhaps a solitary instance of contemporaneous trap of that period in England.

The other fact is, the occurrence of a dyke of greenstone, cutting through and indurating the New Red Marl in North Staffordshire. The knowledge of this case may induce him to modify a statement in which he says, "I am not aware of any satisfactory

proof of contemporaneous volcanic rocks amongst the Secondary formations of Britain, save in the red sandstone of Devonshire, described by Sir H. de la Beche." The dyke here described must be referred in all probability to the Secondary Period.

Of the papers relating to Palæontology, one of the most valuable was that read by Dr. H. A. Nicholson, "On the nature and systematic position of the Graptolitidæ." The affinities of a family of animals of which we have no living representatives will, in all probability, remain a vexed question amongst naturalists. Professor Huxley places them amongst the *Polyzoa*, of the class "Molluscoida." Professor Owen amongst the *Hydrozoa*. The researches of Dr. Nicholson leads him to the conclusion that the family forms a link between the fixed and oceanic *Hydrozoa*, and in this view he appeared to be supported by Sir P. Egerton. As this paper will probably be published *in extenso* in some scientific periodical, it must be left to speak for itself. Mr. H. Woodward presented his third report on the fossil *Crustacea*, describing several new forms, a number of fine specimens of which were exhibited by Mr. Powrie, of Reswallie, and by Mr. R. Slimon. Mr. W. Carruthers gave the results of his investigations on fossil *Cycadeæ* at *Equisitaceæ*.

Much interest was excited when Dr. Oldham, F.R.S., exhibited a large map showing the progress of the Geological Survey of India, and explained the order of succession of the formations of that part of the British Empire, and their correlation with those of Europe. Considering the enormous extent of territory, the smallness of the staff of surveyors, and the physical difficulties to be encountered, the extent of country completed within the last fifteen years is surprising. According to Dr. Oldham's views the age of the Indian coal-fields, the whole of which are included between the parallels of 20° and 25° N. is Upper Carboniferous, of a rather later stage than that of the true Coal-measures of Britain, and more closely allied to the "fern-coal" series of Silesia. We have some doubts as to the correctness of this view, at least of the age of the Silesian coal-fields, which are known to rest on limestones containing large *Producti* and other fossils of the Carboniferous Limestone. Without entering farther on this inquiry, we here subjoin a brief summary of the formations of the Indian Peninsula, as described by Dr. Oldham, in ascending order:—

1. Laurentian? Granitoid Gneiss—highly metamorphic, and traversed by innumerable trap dykes. This is the floor of all the other formations.
2. Quartzose, micaceous, and hornblendic rocks—much contorted.
3. Lower Silurian, or Cambrian.—Sub-metamorphic schists

and massive conglomerates of local rocks. These rocks occur in the Eastern Ghauts.

4. Devonian.—The Vindhyan series, principally sandstones, distributed into four groups.
5. Carboniferous.—(*a*) Mountain-limestone of the Salt Range, classified as such from the fossils collected by Dr. Flemning.

   (*b*) The Talcheer series, sandstones of a peculiar character and colour, resting on a "boulder bed," or ancient shingle beach.

   (*c*) The coal-bearing rocks of India, forming the coal-fields of Damuda, Nerbudda, &c.
6. Permian? or intermediate.—Beds with reptilian remains, representing, in Dr. Oldham's opinion, the physical break between the Palæozoic and Mesozoic periods of Europe. We have ventured to indicate it here as doubtfully Permian.
7. Triassic—Upper and Lower. In this latter there are beds of limestone with *Ceratites* (Muschelkalk?).
8. Rhætic Beds—with characteristic fossils.
9. Liassic Group—divided into an Upper and Lower Series.
10. Jurassic Group—with *Cycadeæ*. Divided into Upper, Middle, and Lower Stages.
11. Cretaceous Series—with fine forms of Ammonites and other shells.
12. Eocene.—(*a*) Nummulitic limestones.

    (*b*) Fresh-water deposits of lakes; over, and through, which sheets of lava have been erupted.
13. Miocene.—"Laterite," and other strata of several kinds.
14. Pliocene.—Ossiferous Gravels, Clays, &c.
15. Recent.—Gravels, Clays, and Mud of Rivers, &c.

It is impossible to look over the above great series of beds, so truly representative as they are of the European system, and presenting often in minute detail a marked correspondence with our own subdivisions and formations, without being struck with the wonderful uniformity of Nature's operations in ancient times over vast portions of the globe. The stratigraphical resemblances are also not less remarkable than the palæontological, for the genera and some species of fossils of the Triassic, Liassic, and Cretaceous formations are identical with those of Europe.

The metamorphic origin of granite gave rise to a lively discussion, and several geologists pressed forward to make a public recantation of the erroneous doctrines they had once maintained on a subject on which some light was thrown during the discussion of Dr. Bryce's paper "On the Granites of Arran." The author

maintained that the two kinds of granite, the coarse and the fine, in that island, had been erupted at different periods, and that the difference in their texture arose from the difference in their ages. This view, however, was opposed by Mr. E. A. Wünsch, who had accompanied Dr. Bryce during his explorations, and preferred to explain the differences in question by the differences in the texture of the original strata previous to metamorphism, a view which appeared to meet with general support.

While on the subject of Physical Geology we may refer to two papers, by Mr. E. Hull, F.R.S., relating to the North-West of England. In the first of these the author showed that the Carboniferous "sedimentary" rocks originally attained in the neighbourhood of Burnley, along the Pendle Range, a thickness greater than in any other part of Britain, and produced sections of the strata, in this and other districts, in confirmation of his views on the south-easterly attenuation of the Carboniferous "sedimentary" strata of the north of England. Taking four sections along a south-easterly line from Pendle Hill, the following were stated to be the comparative thicknesses:—

	North Lancashire.	South Lancashire.	North Staffordshire.	Leicestershire.
Coal-measures . . .	8,260	7,630	6,000	2,500
Millstone Grit Series .	5,500	2,500	1,000	50
Yoredale Series . . .	5,020	2,000	2,000	50
	18,780	12,130	9,000	2,600

The calcareous members are excluded from these sections, as having been deposited on a different plan.

In his second paper, Mr. Hull endeavoured to show that there were three consecutive periods of disturbance of great force affecting the Carboniferous districts of Lancashire. The first and the earliest took place before the Permian period, and produced the upheaval of the Lower Carboniferous rocks along the northern boundary of the Lancashire and Yorkshire coal-fields. The second resulted in the separation of the Lancashire and Cheshire from the Yorkshire and Derbyshire coal-fields, by the upheaval of the Lower Carboniferous rocks along "the Backbone of England;" and might be referred to the close of the Permian, or Palæozoic period. The third had produced the system of north-north-westerly faults which traversed the coal-fields, as well as the Permian and Triassic formations of Cheshire. This system of disturbances the author considered to be referable to the close of the Jurassic period. The

directions of each of these three lines of disturbance were stated to correspond to the sides of a triangle, as follows:—

The 1st. (Pre-Permian) lay in a direction	.	E. 20° N.
The 2nd. (Pre-Triassic) „	.	North—South.
The 3rd. (Post-Jurassic) „	.	N.N.W.

The amount of denudation which took place in some districts of Lancashire during the first period was shown to have been in some cases prodigious. As an example: according to the calculations of the author and Mr. Tiddeman, his colleague on the Geological Survey, strata no less than 20,000 feet in thickness were swept away in the vale of Clithero before the Permian period.

An interesting discussion took place in reference to "Eskers," which is a name given to those lines of gravel found in various parts of Scotland and the North of England. Mr. Milne-Home, in describing a remarkable one in the valley of the Firth of Forth —which is clearly indicated on the Ordnance map—compared it with certain banks found by soundings under the Straits of Dover, as shown by the Admiralty charts. The direction of these submarine banks is found to correspond with that of the tides, and Mr. Milne-Home suggested that the Eskers of the valley of the Forth had been formed when that valley existed as a strait from sea to sea across Scotland, along which the tidal currents flowed.

In tracing the line of an old sea-terrace inland in the same district, Mr. Milne-Home stated that its surface was found to ascend towards the interior from the coast. Sir C. Lyell corroborated this observation, and stated that MM. Bravais and Martin had ascertained that along the coasts and fiords of Norway the old sea-beaches attain an elevation inland many feet higher than along the coast. In order to account for this, Sir C. Lyell threw out a remarkable suggestion. Referring back to the period when these terraces were in course of formation, and the land was submerged to a greater extent than at present, it seemed probable, owing to the proximity to the Glacial Period, that the mountains of the interior were covered by enormous masses of snow, which would exert naturally an attractive power on the waters of the fiords, drawing them up to higher levels in the interior of the country, and producing a corresponding rise in the position of the old beaches.

Mr. C. W. Peach, whose discovery of Lower Silurian fossils in the limestones of Duirness led the way to the reconstruction of the Geological map of the Highlands of Scotland, and enabled Sir Roderick Murchison to add to his many honours as an original explorer by the establishment of the Laurentian system as the base of the British formations, was present at the Section C, and read an interesting paper on some new forms of fishes from the Old Red

Sandstone of Caithness. Mr. Pengelly, F.R.S., the leader of the band engaged in the exploration of Kent's Cavern, Devonshire, produced additional evidence, if such can be required, that man was a contemporary with the mammoth in the British islands. Mr. George Maw, F.G.S., exhibited some very nature-like drawings of the Cambrian rocks of Llanberris Pass, lately exposed to view in the new railway-cutting connecting that pass with Carnarvon. In one of these sections an apparent unconformity was observable between two series of slate rocks, which, if confirmed by subsequent investigation, will prove a new feature in the Geology of that district.

We regret that space will not allow of further observations on several interesting papers, such as those of Dr. Collingwood on the coal-beds of Formosa, and Dr. C. Le Neve Foster on the Mines of magnetic iron-ore near Philipstadt in Sweden. Several papers of value received but scant attention, owing to the numbers which were set down for reading, and the shortness of the time which could be allotted to them for the purpose. Should this occur on future occasions, it may be necessary for the Committee to exercise discretionary power in rejecting some communications of minor importance, or such as deal with subjects of a purely speculative character, in order that due time may be given to those of a more substantial nature, and which contain observations new to Science.

Biology. (Section D.)

Section D this year met in two departments, one of Zoology and Botany, the other of Anatomy and Physiology. No application was made for an Anthropological department, and consequently no such department was formed. The authorities of Section E were averse to the formation of a separate Anthropological department, because Anthropology forms one of the most attractive and important subjects in their own Section. Next year it is not at all improbable that Section E will receive a new title indicating this fact, and Geography will very properly be made subordinate. A misunderstanding as to the suppression of the department somehow or other arose amongst the local Anthropologists, and the Dundee papers contained accounts of "indignation meetings" and an "Anthropological conference" to be presided over by Dr. Hunt. Matters were, however, eventually set right and the indignant persons acceded to the arrangements of the Association. Dr. Sharpey, Sec. R.S., Professor of Physiology in University College, London, was President of the Section, and kept to the department of Physiology and Anatomy; whilst Mr. George Busk, F.R.S., took

the chair in the department of Zoology and Botany. Sir John Lubbock, Mr. Alfred Wallace, Mr Gwyn Jeffreys, Professor Newton (Cambridge), Professor Balfour (Edinburgh), Dr. Hughes Bennett, Professors Turner, Michael Foster, Cleland, Allen Thomson, and Dr. Richardson were amongst those who took part in the discussions. On Thursday morning the proceedings of the Section were commenced by an address from the President. Dr. Sharpey gave a very interesting account of the recent progress in Physiological Science, alluding to new discoveries, and the application of new instruments of research. He dwelt on certain practical matters, which he considered of great importance, such as the publication of records of progress, and of good and careful illustrations to memoirs. Besides having scientific functions, the British Association was the means of bringing together men in friendly intercourse, which he considered one of its most important offices.

Taking the reports and papers as we have done before in order of subjects, we commence with those on General Zoology and Botany. Mr. Spence Bate, F.R.S., read his "Report on the Marine Fauna and Flora of the Southern Coasts of Devon and Cornwall." He submitted lists of the various Mollusca, Annelids, and Fishes which had been obtained; his own attention had been directed to the Crustacea, of which he described some new species, and some highly interesting larval forms.

Mr. Gwyn Jeffreys, F.R.S., read his fourth report "On Dredging among the Shetland Isles." He recorded the occurrence of many interesting forms of Mollusca; and a preliminary report on other classes of marine animals, obtained by him, was furnished by the Rev. A. M. Norman. Dr. M'Intosh stated that Mr. Jeffreys had obtained for him a very fine lot of Annelids from Shetland, which filled 118 bottles, and promised to be one of the richest collections yet obtained. Mr. Jeffreys, in his report, made some remarks on the large size attained by species of Mollusca when living in boreal seas, as compared with that which they exhibited in more southern latitudes: he also drew attention to a ferret's tooth and some fragments of bone which had come up in the dredge; they had especial interest, as bones were hardly ever found in this way, and opened up the question of the corrosive action of the sea and its relation to the preservation of bones in a fossil condition. Mr. Busk considered this as a very important inquiry in relation to the antiquity of man; and suggested that experiments should be made as to the time and conditions of corrosion by the sea. Dr. Günther drew attention to the occurrence of some Madeiran species of fish amongst those obtained off Shetland. He could only account for their presence by the existence of a

current running up from the latitude of Madeira along the west coast of Iceland, and bending eastwards towards Scandinavia.

Dr. M'Intosh read some notes on Annelids from the Hebrides, obtained by Mr. Jeffreys last year, amongst which were some new and interesting forms. The same gentleman also read a paper "On the Marine Fauna of St. Andrew's," which he had most carefully explored. To the Annelids and Turbellarians he had specially devoted his attention, and he exhibited some exquisitely finished drawings of these animals, which were highly eulogized by Mr. E. W. Cooke, R.A., who was present. He had obtained 104 species of Annelids and Turbellarians from St. Andrew's, of which several were new to Britain, and some new altogether.

Dr. Cuthbert Collingwood had no less than five papers on marine animals, which he had briefly observed in his recent voyage to the Chinese seas. They were as follows: "On Pelagic Floating Animals observed at Sea;" "Notes on Oceanic Hydrozoa;" "Observations on the Habits of Flying Fish;" "On Trichodesmium, or Sea-dust;" and "On some remarkable Marine Animals observed in the China Seas." These papers were chiefly interesting as containing personal observations on the habits of the creatures mentioned. Dr. Collingwood had a large collection of specimens in spirits which he submitted to examination.

Dr. Spencer Cobbold, in a paper "On the Entozoa of the Common Fowl and of Game Birds," gave his reasons for believing that the grouse disease was not in any way due to the presence of Entozoa. He described the species of flat, round, and tape-worms, which are to be found in these birds. His paper caused some discussion, in which the Rev. H. B. Tristram and Mr. Busk agreed in condemning the destruction of birds of prey by the game-keepers. Falcons and hawks act as nature's police, and check the spread of disease and epidemics amongst birds by killing off the weakly individuals of a covey.

Mr. C. W. Peach, a veteran zoologist who has done very much good work in dredging and exploring, read a paper "On some New British Naked-eyed Medusæ;" and another "On the Fructification of Griffithsia Corallina," found by him in Shetland.

Professor Alfred Newton read a "Supplement to the Report on the Didine Birds of the Mascarene Islands." The grant given by the British Association had been spent by Prof. Newton's brother in the most satisfactory way, for he had before him almost complete skeletons of the Dodo of the Island of Rodriguez,—the Solitaire. When the skeleton of the *Didus ineptus* of Madagascar had become known such a very short time since, it was highly satisfactory to obtain such complete evidence with regard to this allied species.

Leguat, who figured the bird some two hundred years since, mentioned that at the tip of the wing was a hard knob, as big as a musket ball, with which the bird could strike. The bones obtained by Professor Newton completely confirm this account, for a large bony knob is present on the free end of each wing-bone. Professor Newton considers that his new material quite justifies the establishment of the genus *Pezophaps*, proposed by Strickland on the very slender evidence he had at hand a few years since. The Dodo of Réunion yet remains to be investigated, and the French naturalists, it is hoped, will search out its remains. Mr. Busk remarked on the wanton destruction of the Dodo by men, and animadverted on similar destruction of rare animals and birds in our own country. Prof. Newton believed that the Dodo in Rodriguez had been destroyed by the herds of pigs which the sailors had left there,—a fat awkward bird like the Dodo would have but small chance against a hungry boar.

There was a fair number of papers on the occurrence, &c., of various plants. Mr. Carruthers, of the British Museum, read a paper on "The British Fossil Cycadeæ," in which he described some new genera and species, and pointed out the relation of the fossil Cycads to living plants.

Passing on (as our space compels us to do) we come to papers on ANATOMY.

Dr. Anton Dohrn, of Jena, made a highly interesting communication "On the Morphology of the Arthropoda." He was only able briefly to give the results of some extended researches in which he had been seeking to adopt the Darwinian hypothesis as a basis of classification. He believed that all Crustacea, Insects, Arachnida, &c., could be traced to a single parent form, which they each reproduced at one or other period of development; this form was identical with the larva of Cirripedes; and he gave it the name Archizoëa. All Arthropods had originally sprung from such a parent; and he endeavoured to show further how the various groups of that sub-kingdom were related in their descent. Classification means a genealogical tree to the disciple of Darwin; and the doctrine of "types" to him becomes intelligible. Sir John Lubbock and Mr. Spence Bate discussed certain parts of the paper, at some length.

Sir John Lubbock read a paper "On Some Points in the Anatomy of the Thysanura." Sir John has been working for some time at the Springtails, on the British forms of which group he is preparing a monograph for the Ray Society. Some of the drawings for this work, very beautifully coloured, were shown.

Mr. E. Ray Lankester described some new and important points

in the "Anatomy of the Limpet;" which he had been investigating with Professor Rolleston, of Oxford.

Professor Turner, of Edinburgh, read a "Contribution to the Anatomy of the Pilot Whale." He described the anatomy of the stomach, the distribution of the great arteries which arise from the arch of the aorta, and some features in the cervical vertebræ of a specimen which he had dissected during the spring and summer of this year. The stomach of the pilot-whale was compared with that of the porpoise, and it was pointed out that in the former a greater number of compartments existed than in the latter.

Sir Duncan Gibb read a paper "On the Influence of Pendency of the Epiglottis upon Mankind at large." He had found that about eleven per cent. of Europeans had the epiglottis hanging down over the windpipe instead of erect; and he believed that such a condition prevented clearness in singing and speaking, and also produced a sluggishness of disposition, in consequence of retardation of respiration. Of 280 Asiatics (male and female) examined by him, all had a more or less pendent epiglottis, which was a very startling fact; and was probably connected with their incapacity for fine singing.

Professor Allen Thomson exhibited some "Microscopical Preparations of the Cochlea, of the Retina, and of Teeth of Fossil Fishes." He made a very important suggestion at the same time. Members of Section D had often found the inconvenience of exhibiting their microscopical specimens on the platform of the meeting room, where proper attention could not be paid to them, nor discussions entered upon in a satisfactory way. He proposed that at the next meeting of the Association a room should be set apart for microscopes, where members could examine specimens at their leisure, and confer with one another concerning them; other specimens of microscopic anatomy were exhibited by Professor Cleland, Professor Turner, and Dr. M. Foster.

We come now to the third head under which we arrange the papers read, *viz.* PHYSIOLOGY, the reason why structures and species exist, and how they exist.

Mr. Wallace had a most interesting paper "On the Relation between Sexual Differences of Colour and the Mode of Nidification in Birds." He ran over in detail the principal species of birds, having the female as beautiful and brilliant, or as conspicuous as the male. In cases where the female has this conspicuous appearance, the nest always conceals the female, and in cases where the female is of a dull colour, the nest exposes a considerable portion of the sitting bird. When the male bird is less brilliant than the female, it is found that the male performs the duties of incubation. There thus seems to be a connection between the colour of the different sexes

of birds and the sitting over the eggs. There are some exceptions to this generalisation, but they can be easily explained, for these are generally protective colours. Mr. Wallace considered that Darwin's principle of natural selection most aptly explained this connection of colour and nests.

Mr. E. Ray Lankester drew attention to the "Boring of Limestone by Annelids" in a brief paper. He stated that, in the discussions concerning the boring of Molluscs, no reference had been made to the boring of Annelids—indeed, they seemed to be quite unknown—and brought forward two cases, one by a worm called *Leucodore*, the other by a *Sabella*. *Leucodore* is very abundant on some shores, where boulders and pebbles may be found worm-eaten and riddled by them. Only stones composed of carbonate of lime are bored by them. On coasts where such stones are rare, they are selected and all others are left. The worms are quite soft, and armed only with horny bristles. How, then, do they bore? Mr. Lankester maintained that it was by the carbonic acid and other acid excretions of their bodies, *aided* by the mechanical action of the bristles. The selection of a material soluble in these acids is most noticeable, since the softest chalk and the hardest limestone are bored with the same facility. This can only be by chemical action.

Dr. M'Intosh described a series of "Experiments with Poisons, &c., on young Salmon," in which he detailed the action on the heart, &c., of Aconite, Digitalis, Chlorine, and other poisons.

Dr. Ogilvie described the "Adaptation of the Structure of the Shell of the Bird's Egg to Respiration." He pointed out, in diagrams of various egg-shells, the existence of pores similar to the stomata of the leaf of a floating water-plant, the resemblance between which structure and an egg-shell is very remarkable.

Dr. B. W. Richardson had three papers,—one, his "Report on Methyl Compounds," in which he described the physiological action of several bodies allied to Chloroform, and recommended the Bichloride of Ethylene as a substitute for that anæsthetic. In another, "On the Coagulation of the Blood," he renounced the Ammonia theory, which he put forward some years since, and for his essay on which he gained the Astley Cooper prize medal. He now substitutes another hypothesis connected with some peculiar notions of his own on heat. In a third paper, he described some "Effects produced by applying extreme Cold to certain Parts of the Nervous System." By means of his Ether-spray apparatus he froze his arm and produced anæsthesia; he also produced torpor in a frog by freezing the brain; and he described experiments in which he had frozen various parts of the brain in birds—the freezing acting as effectually as excision, or even more so. The Ether-

spray might, he considered, without doubt, be made a valuable means of research in this manner.

Dr. G. Robinson, in a paper on "Certain Effects of the Concentrated Solar Rays upon the Tissues of Living Animals immersed in Water," tried to show that it was not the calorific effect by which aquatic animals were killed when placed in a focus of sun light, but some other actinic or electric action.

Professor Hughes Bennett read two papers, one being an account of "New Investigations to determine the Amount of Bile secreted by the Liver;" the other, on "Protagon," a body which may be obtained by treating yolk of egg with alcohol—the chemical composition Dr. Bennett does not appear to know. This Protagon when placed in water assumes "cell-forms," and re-acts with acids and other re-agents, as many cells do.

Mr. E. Ray Lankester read a paper on "Observations with the Spectroscope on Animal Substances," and obtained a grant of 15*l.* to continue his researches.

Other Physiological papers were, by Dr. Polli, "On the Antiseptic Properties of the Sulphites;" by Mr. Wesley Bennet, "On the Influence of Fluids on the Body;" by Mr. Wentworth Scott, "On the presence of Quinine and other Alkaloids in the Animal Economy;" by Mr. Dunn, "On the Phenomena of Life and Mind;" and by Mr. Melville, "On Life—its Nature, Origin, &c." The last two papers were highly metaphysical, and called forth considerable discussion, though hardly rightly belonging to Physical Science at all.

We now have briefly to mention certain papers read which are of considerable importance, and come under our fourth heading of PRACTICAL papers.

They are—Mr. Andrew Murray, "On the Future Administration of the Natural History Collections of the British Museum;" Mr. W. Brown, "On the Claims of Arboriculture as a Science;" Dr. Lauder Lindsay, "On the Conservation of Forests in our Colonies;" "On Lichen Growth as a Criterion of the Age of Prehistoric Structures;" "On Lichen Growth as Detrimental to Forest and Fruit Trees;" "On Plant Acclimatization in Scotland, with special reference to New Zealand Flax;" Dr. Grierson, "On the Destruction of Plantations at Drumlanrig by a species of Vole;" Rev. H. B. Tristram, "On the Zoological Aspects of the Grouse Disease;" Sir James E. Alexander, "On the Preservation of Fishing Streams." Mr. Murray advocated the appointment of a single Crown minister who should be responsible for the management of the British Museum, instead of the irresponsible board of trustees who govern it now and who cannot be got at. He also advocated the exchange

of duplicates and the better payment and increase in numbers of the staff of curators. Mr. Wallace, Mr. Busk, Mr. Carruthers, and others took part in a highly interesting discussion which followed, nearly all were opposed to the exchange of duplicates, but agreed with Mr. Murray in most other respects.

Mr. Busk, in remarking on the papers relating to Arboriculture, mentioned the fact that Gibraltar and Malta suffered from want of water simply because the trees had been cut down. This was also the case in Spain, and the importance of this matter could hardly be overestimated. Foreign governments had taken the matter in hand, and the art of the "forester" was carefully studied abroad.

Mr. Tristram, in his paper, drew attention to the folly of destroying birds of prey, since they checked the spread of disease among game-birds. The Duke of Buccleuch and Sir John Ogilvy concurred with the reverend gentleman, and considered that the game-laws ought to be extended to vermin in order to ensure the preservation of game. It is to be noted, however, that if there were no game-preserving at all, there would be no epidemics among game-birds.

Sir James Alexander's paper related chiefly to the local arrangements in Scotch Salmon-rivers.

Among the grants of money obtained by Section D, is one of 100*l.* to Sir John Lubbock, to assist in the preparation of the 'Zoological Record,' of which we have had to speak so well before in these pages.

A recommendation on the management of the Natural History Collections of the British Museum was also forwarded to the Parliamentary Committee by Section D.

Geography and Ethnology. (Section E.)

This Section sat on five days, from Thursday, September 5, to the Tuesday following, including Saturday, when every other Section adjourned for the excursions. The place of meeting was the Great Hall of the new Albert Institute (of which Mr. Scott is the architect), a fine apartment, with a very beautiful and simple Gothic-arched roof, but so ill-adapted for hearing that only one or two speakers with exceptionally powerful voices were ever audible beyond the centre of the room. As is usually the case, this Section was better attended than any other, although the acoustic deficiencies of the Hall prevented it from being so well filled as it otherwise would have been. The first meeting was particularly well attended to hear the President, Sir Samuel Baker, deliver his opening address, he being almost the only man present at this

meeting of the Association who excited any unusual interest, or could aspire to the reputation of a "lion."

Every one must have noticed the tendency of many speakers at Dundee to adapt themselves to the prevalent theological opinions of the Scottish people, and certainly either Sir Samuel Baker has much narrower views on these subjects than most men of such a wide experience of life, or he illustrated in a remarkable manner that capacity of being "all things to all men," which is perhaps an essential part of a successful traveller's character. His address was a long one, occupying three quarters of an hour of rapid speaking. It was well written and eloquently delivered, and though a captious critic might object that it contained too frequent references to his own travels and too much glorification of the Royal Geographical Society, it was always interesting and sometimes instructive. A few extracts will best illustrate those references to religion which were so frequently indulged in, and which, however questionable in point of taste, were well received by the local portion of his audience.

"Theology is closely interwoven with the study of Geography; the history of man from the remote beginning is linked with a description of the creation of the world, when God said—'Let us make man in our own image.' From that time the very elements of our creed are connected with particular positions upon the earth's surface. The most important events that have influenced the march of civilization and the spread of Christianity have occurred in certain places that throw intense interest upon the science of geography. The wanderings of certain nomadic tribes seeking for new pastures for their flocks have brought to light new countries, and have implanted new religions. The arrival of Abraham from Chaldea, the simple Arab chieftain with his followers, who settled in a new country, laid the foundation of our Jewish history, followed by those mighty events, at distant intervals, the Exodus from Egypt, the building of Jerusalem, the birth of Christ, the Roman conquest; until at length by the victories of Cæsar, the West was rescued from its savagedom, and the road was opened to Great Britain, to be followed by the light of truth. All this wonderful train of progression is based on geography."

The papers read on the first day's sitting were very inferior and uninteresting, and excited very little discussion. One by Captain Maury on the "Physical Geography of Nicaragua," repeated those views on the "great equatorial cloud-ring," which are to be found in his published works, and have so frequently been explained in public. Mr. Crawfurd's paper on the "Australian Aborigines" was no doubt a useful summary for visitors, to whom his ideas and style were novelties, but contained nothing worthy of a permanent record.

On Friday Sir Roderick Murchison's promised exposition of his views respecting Livingstone's fate, attracted a crowded audience and excited much interest. He went over a great deal of ground, giving a general sketch of the discoveries of Burton, Speke, and Baker, and arguing that on general grounds it was not likely that a man like Livingstone, who had gone across Africa on foot, with no assistance except from natives, should fail on an expedition in which he was assisted by Government and backed by the Royal Geographical Society. This argument, however, is transparently weak (since no precautions can guard a man in a strange country from the attacks of the natives), and Sir Roderick therefore lays most stress on the known bad character of Moussa, the Johanna man, who is the sole witness to the fact of Livingstone's murder, and on his having given two inconsistent versions of the story. Sir Samuel Baker, on the other hand, whose knowledge of African character and habits can hardly be disputed, admits that Moussa, like most natives, is a great liar, but says that it is for this very reason he believes him. The paradox is easily explained. The natives are skilful and artistic liars, and one of the canons of their art is, never to tell a lie of which you may be any day convicted. No native would ever run away from his European master, and exculpate himself by saying he saw him murdered, because the very next day or week his master might return and convict him of a lie, as well as of cowardly desertion. From the nature of the country and the character of its inhabitants, the fact of a traveller being murdered by them is in itself probable, and when his chief native guide says he saw it done, the evidence is to be relied on, because it would be too inartistic and easily disproved a falsehood for a clever native to be guilty of.

The only other papers that were of any interest this day were those on Palestine, by Captain Wilson, of the Palestine Exploration Fund, Lieutenant Anderson, and the Rev. H. B. Tristram; but they contained little matter of note beyond an account of the progress in mapping the country round Jerusalem, and the discovery of some fine architectural remains, and the system of aqueducts by which the city was supplied with water.

On Saturday Mr. Crawfurd did his best to supply both instruction and amusement to those who did not go on the excursions, by reading three papers, all of which excited some discussion. The first was on the Antiquity of Man, and was a resumé of the main arguments on this subject, interspersed with Mr. Crawfurd's peculiar views on language and on the dependence of man's mental and physical condition on the country he inhabits. He adverted to the evidence of a high civilization at a very early period afforded by the pyramids of Egypt, which the best authors considered to be more than 5,000 years old; to the unknown antiquity of the distaff

and the loom; and to the proof afforded by language of the remote origin of mankind.

Sir John Lubbock showed that Mr. Crawfurd had understated the number of actual remains of man which had been found in such positions as to show that they were contemporary with extinct animals, coeval with the makers of the most ancient flint implements, and of such a high antiquity that the period of actual history sinks into comparative insignificance. He concluded by remarking that it had been said that certain papers had been refused at this meeting, because the British Association did not wish to excite feelings of hostility on the part of the people of Dundee,—but he thought that the paper to which they had just listened was a very good answer to any remark of that kind. He was quite sure that very few people would suppose that the British Association would pay so bad a compliment to the inhabitants of this part of our island as to suppose that they would meet with a different reception here from that which they were accustomed to meet with elsewhere in discussing such questions, and it was a very bad compliment, either to the people of Dundee or to the members of the British Association, to suppose that these interesting and important questions could be discussed in any other spirit than that in which they had been ventilated in other parts of Great Britain.

Dr. Hunt objected to Mr. Crawfurd's statement that the earliest men were speechless, and said that he could not apply the term "man" to a race of beings without speech. He also adverted to the fact that Bunsen, a great authority in favour of the unity of man, had said it was utterly impossible to explain it in less than twenty thousand years. Mr. Crawfurd caused some amusement in his reply, by stating that all the facts relating to the geological history of man which Sir John Lubbock had criticized were taken out of Sir John Lubbock's own book, and concluded with his usual ridicule of the "unity" theory.

Mr. Crawfurd's next paper was on "Skin, Hair, and Eyes as Tests of the Races of Men." Of these he seemed to think the colour of the skin was the most important, while Dr. Hunt maintained that the character of the hair was extremely valuable, and both agreed that we have yet no evidence whatever as to the causes which have produced these peculiarities, although they were certainly not the effects of climate alone. The only attempt at generalization was made by Dr. Hunt, who stated that "a dark colour of hair and eyes, combined with curly hair, was always a mark of mental inferiority," and challenged anyone to bring forward an exception.

Mr. Crawfurd's last paper was on a subject of which the popular knowledge is very scanty:—"The supposed Aborigines of India as distinguished from its Civilized Inhabitants."

"In many parts of India there existed," he said, "rude and even savage tribes, differing widely in manners, customs, religion, and not unfrequently even in language, from the great body of the civilized inhabitants. People in that state of society were found only in hilly or mountainous districts, more or less inaccessible, and by their comparative sterility holding out little temptation to conquest and occupation. They were never seen in the fertile and well-watered alluvial valleys of the great rivers, which, on the contrary, were inhabited by civilized nations, however differing among themselves in manners and language. Linguists and craniologists had invented a theory to account for this state of things, which supposed the rude mountaineers to be the sole aborigines of India, while it imagined the civilized inhabitants to be intrusive strangers, who in a remote antiquity invaded India, conquered it, and settled in it under the imposed names of Aryans for Northern, and Turanians for Southern India." This view appeared to him utterly groundless, and he went into a lengthy description of the history of the people, their manners and mode of life, and quoted several accounts of the several tribes, in order te refute the view which he had mentioned. After an elaborate paper he concluded:—"The mind may safely carry us back to a time in which the social state of India was similar to that of America, when the civilized tribes were few in number, and the wild or savage formed the majority. The Hindu is, beyond all question, a far more highly endowed race of man than the Red man of America; and civilization would probably spring up earlier, at more points, and attain a higher maturity in India than it did in America. We may even point at the localities in which civilization is most likely to have had its earliest seats. Separate and independent civilizations would probably spring up in the plains watered by the 'Five Rivers,' in the upper valleys of the Jumna and Ganges, in the central and in the lower valley of the Ganges, and in the valleys of the rivers of Southern India, such as that of the Nerbudda, the Godavery, the Kistna, the Cavery, and the Taptee. These nascent civilizations would be independent of each other, and for a long time be as unknown to each other as were the Mexican and Peruvian. All this most probably happened long before there was an Aryan invasion, or a religion of Bramah. The state of India at such a time would be a parallel to that of America on its discovery; the wild and savage tribes would be numerous, and the civilized few in number. Proportionate to its extent, it would have as many small tribes, speaking as many distinct languages as America itself. India has still a score of nations with written languages, but the number of its wild tribes have not yet been counted."

Altogether, although containing no original matter, we must admit that Mr. Crawfurd's papers were well adapted to excite

interest on some of the great questions connected with the study of man, and may do more good among the visitors to the Association than the papers contributed by those scientific workers who, by their researches or discoveries, have contributed their quota to the mass of human knowledge.

On Monday morning considerable expectation was excited by the announcement of a paper by Sir John Lubbock on "The Early Condition of Man," which was the first on the list. The paper was evidently composed expressly for a Scotch audience, and though many of the scientific members of the Association thought it was too much like crushing a fly with a sledge-hammer, the sequel showed that Sir John had well estimated the state of knowledge and feeling of his audience. The paper was a careful and elaborate refutation of the doctrine advocated by Archbishop Whateley, that man never could and never did emerge unassisted from a state of utter barbarism into anything that can be called civilization, and that all savages are the degenerate descendants of more civilized peoples. Numerous cases were adduced to show that savages do advance, and the absence of cultivated plants or domesticated animals run wild in any country inhabited by savages was strongly insisted on, since we know that when now introduced by civilized man these species do spread and maintain themselves often to the extermination of native races. So the absence of pottery is a conclusive proof that savages have not descended from civilized races, because pottery is indestructible, though easily broken. The absence of terms for the ten numerals in so many savage languages was another proof of their original barbarism, since these were such useful and such simple terms that we cannot imagine them if once known ever to have been forgotten. Again, the stone weapons found in civilized countries getting ruder and ruder as they can be shown to be older and older, proves the same thing, as do the relics of barbarous customs traceable even among the most civilized of modern nations.

Profsssor Busk raised the previous question of "What is Civilization?" It can be variously defined, and in some respects the moderns have not advanced beyond the Ancient Greeks.

The Rev. H. B. Tristram made several objections, and asserted his own belief in the theory of degradation. Dr. Hunt said that this was the first really scientific and satisfactory reply that had been made to Dr. Whateley, and he was surprised that any member of the British Association could be found who supported the same views. He disagreed, however, from Sir John Lubbock as to there being any nations who had raised themselves, and asked that they should be pointed out.

In his reply, Sir John Lubbock said that the fact that Dr. Whateley's views had been supported in that room showed that the

present paper was not so unnecessary as Mr. Crawfurd seemed to suppose. As to defining "civilization," he thought his friend, Professor Busk, was a very good specimen of a civilized man, and he named the Chinese, Mexicans, and Egyptians as nations who had raised themselves without external assistance to a certain amount of civilization.

It may be remarked, that in the next morning's issue of the 'Dundee Advertiser' the editor expressed his surprise "that no local man stood up to confute the theory of man's original barbarism; for no one who believed that Adam was created a civilized being could have received Sir John's theory of man's creation without a protest."

The next paper was one by Dr. Davy, on "The Character of the Negro," which excited more warm discussion than had yet been raised. Dr. Davy vindicated the Negro against the charge of inveterate idleness, and showed that, under sufficient stimulus, he was as industrious as most European labourers. The discussion diverged into the moral and intellectual character of the Negro, most of the speakers maintaining that whenever a supposed Negro exhibited any marked mental superiority it was due to his having an admixture of white blood in his veins.

On Tuesday morning Sir Roderick Murchison gave notice that "The International Congress of Anthropology and Prehistoric Archæology" proposed to hold its session in England in the year 1868, and that the Presidency had been offered to himself. He had, however, declined that honour, on the ground that Sir Charles Lyell, Sir John Lubbock, and several other eminent men had devoted much more time and study to that branch of Geology than he had done.

The indefatigable Mr. Crawfurd then again appeared with a paper on "The supposed Plurality of the Races of Man," in which he maintained that there was no proof whatever that the races of mankind had been derived one from the other; and went into a long discussion of the facts relating to domestic animals, which, he maintained, showed that the arguments for the unity of man were fallacious. The Chairman, Sir Roderick Murchison, then called attention to the fact, that neither Mr. Crawfurd nor himself were Darwinians; and Mr. G. Vivian made a long and elaborate speech, in which he controverted Mr. Crawfurd's views both on geological and theological grounds, and expressed his own belief in a limited form of Darwinism. Mr. Wallace followed with an attempt to disprove Mr. Crawfurd's theory, by showing,—first, that accepting the facts adduced in the paper, all fair analogy from domestic animals and plants in those cases where we know their history best, is in favour of the unity of man. Secondly, that the known migra-

tions of mankind render his diffusion from a single origin a matter of no difficulty; and thirdly, that, accepting the fact of man's immense antiquity, and the laws of variation and survival of the fittest, which Mr. Darwin had shown to exist throughout all organic nature, it was easy to understand how the varieties we now find could have been produced. Mr. Crawfurd replied by ridiculing the theory of the development of monads into monkeys and men, which he persisted in attributing to Mr. Darwin.

Mr. Crawfurd then read another paper on the "Migration of Sugar-producing Plants," which caused no discussion; after which a vote of thanks was passed to the author for the numerous papers he had contributed.

The proceedings of this Section terminated by the reading of a paper of much interest, "On the Wild Indians of Peru," by Antonio Rainioudi, Professor in the University of San Marcos, Lima. These Indians were called Campas. They made only a shelter of leaves for houses; the men were idle, the women slaves. Their language was full of vowels; they could only count to four. They had no idols or religious ceremonies, and threw their dead into the river with a stone tied to the body to make it sink. The posterior part of the cranium was much developed as compared with the anterior part, the orifice of the ear being thrown much forward, and the author thought the position of the ear was of much importance in comparing the intellectual development of different races.

As a whole, the proceedings of this Section were somewhat below the average of interest. The only complete and carefully prepared papers were those of Sir John Lubbock on the "Early Condition of Man," and Mr. Crawfurd on the "Races of India,"—while the former alone could lay claim to any connected and exhaustive reasoning. The want of some preliminary arrangement of the papers was also seriously felt. On each of the subjects of "Palestine" and the "Isthmus of Panama," there were several papers which, if grouped together and cut down to the really original and interesting matter in each, might have furnished interesting matter for a day's discussion. These were, however, read for the most part separately, and weary repetitions of uninteresting and well-known details formed their prominent feature. The Ethnological papers and discussions were those from which the people of Dundee probably derived most amusement and information, as well as some new and, to them, startling ideas.

Mechanical Science. (Section G.)

Instead of opening the business of the Section by a formal address, the President, Professor W. J. M. Rankine, recapitulated

the principal points in the history of the work done by the Section since the year 1850, when he joined the British Association, believing that work to be the most important which consists in receiving reports of scientific researches made during the previous year, and in planning those to be made during the ensuing year, whether by observation and experiment, or by collecting and arranging existing information.

He classified the subjects of the reports in a masterly manner, and in several instances paid deserving compliments to the persons who had instituted experiments and compiled the reports named. The following is the classification of the contents of the Reports:—

I. Strength of Materials.
II. Motive Power.
III. Hydraulic Engineering.
IV. Shipbuilding and Steam Navigation.
V. Conveyance.
VI. Metallurgy and Agricultural Machinery.
VII. Weights and Measures. 1864–5–6.
VIII. Patent Laws. 1858–9, 1861.
IX. Scientific Evidence in Courts of Law. 1866.

The first paper read was an abstract of a Report on the "Condensation and Analysis of Tables of Steamship Performance," as published in the years 1857, 1858, 1859, 1860, 1861, and 1862. The Committee (appointed at Nottingham in 1866) being J. Scott Russell, William Fairbairn, Thomas Hawksley, James R. Napier, and W. J. M. Rankine. The large collection of the records of steamship performance has now been rendered useful for practical and scientific purposes by this Committee. The data contained in those records have been condensed and re-arranged according to a method, the leading principles of which may thus be summed up:—All results belonging to any special theory, and all quantities calculated by inference, or ascertained otherwise than by direct measurement, are excluded from the condensed tables; vessels for which certain essential data are wanting are excluded (the essential data being such as the principal dimensions, displacement, kind of propeller, speed, indicated horse-power, &c.); the vessels inserted in the condensed tables are divided into groups, according to their full speed, and very numerous groups are subdivided according to the displacement; a uniform arrangement of the data is adhered to as far as practicable; and the tables are drawn up in such a form as to be printed in octavo pages.

Mr. J. V. N. Bazalgette drew the attention of the Section to the desirability of placing permanent topographical indicators on those mountain summits which are visited by tourists, so that they may be supplied with reliable information regarding the direction,

distance, &c., of objects of interest visible from those summits, and in the case of mountains, their heights above the sea-level. The author recommends a circular table of stone or metal, on which circles and radial lines should be engraved, showing in one case the distances, and in the other the directions of the objects to be looked for. A district thirty miles in radius would generally be found sufficient, and for the names of all the objects of interest embraced within that area a table of three feet would probably suffice. Mr. Bazalgette also recommends that a revolving telescope be fixed in the centre of the table, and a light ornamental place of shelter, both for the indicator and the tourists. Such an indicator is being erected by Mr. Bazalgette on the summit of the Malvern Beacon Hill, Worcestershire, an elevation of nearly 1,500 feet above the sea-level.

The President highly commended Mr. Bazalgette's recommendation as being simple and likely to be extensively followed, and hoped the people of Dundee would show their appreciation of it by forthwith erecting an indicator on the Law of Dundee, an admirable place for such a useful thing.

"The Construction and Works of the Highland Railway" was the title of the next paper, the author of which was Mr. Joseph Mitchell, C.E. It embraced an elaborate account of the difficulties encountered in constructing the railway, and many very valuable data regarding the works. The Central Railway from Dunkeld to Forres, is a single line 104 miles long, with 8 viaducts, 126 bridges over streams, 119 public and accommodation road-bridges, and 1,159 covered drains, from 18 to 36 inches square. The total cost per mile was 8,860*l*. The future utility of this railway may be estimated by the fact that in one week the Company carried no fewer than 21,000 sheep over it. The summit of the line is 1,500 feet above the level of the sea, or 500 feet higher than the summit of the Caledonian line. Notwithstanding its high northern latitude and its exposure to snow-storms, those of last winter in no way interrupted the traffic on the Highland Line, and yet the traffic on other lines in Scotland, England, and France was stopped for a length of time varying from 12 or 16 hours to five or six days. On this line screens are erected to intercept the snowdrifts in exposed places, and where these are not sufficient snow ploughs are used, one of them being able to clear a depth of 10 or 11 feet of snow with the aid of four or five goods-engines. Another branch of the Highland Railway, from Invergordon to Bonar Bridge, 26½ miles long, has been constructed at a total expense of 5,888*l*. per mile.

Professor Rankine, in proposing a vote of thanks to Mr. Mitchell for his paper, said it was one of the most interesting that would come before the Section, as the information contained in the great

collection of facts relating to bridges would be most valuable to civil engineers in preparing estimates for new works. The Highland Railway passed through such a rugged description of country that the difficulties of construction were very great. Looking at the diagrams furnished by Mr. Mitchell, the substantiality of the works, the moderate cost of execution, and the remarkable judgment with which the various works had been suited to the different situations must have struck every civil engineer in the room.

The next communication was by Mr. John Fernie, of Leeds, on "The Iron and Steel at the Paris Exhibition." Mr. Fernie considered that the great duty imposed on British manufactured iron now imported into France amounts almost to a prohibitory tax, while raw iron is admitted at a very small duty, and coal duty free. He thought that France had not surpassed Britain in iron-making in any of its departments, but that Krupp and the Bochum Company had shown larger masses of steel than England had as yet manufactured, and that the Bochum Co.'s cast-steel railway-wheels were the finest ever exhibited. The President, Mr. Foster, and Mr. Ferdinand Kohn (of "*Engineering*") joined in an interesting discussion on the subject raised by Mr. Fernie's paper. At a subsequent sitting of this Section Mr. Kohn also read a paper on the subject, specially referring to the interest and curiosity excited by the extraordinary sizes and qualities of the steel castings of Rhenish Prussia, and by the secrecy and mystification surrounding their manufacture. A professional survey of the Paris Exhibition, extending over many weeks, had led him to conclude that there was no ground for the notion that the predominance and superiority of the British iron-manufacture had ceased to exist, or were threatened to be overthrown by continental competitors.

Mr. David Greig, of Leeds, read a paper on "Steam Cultivation: Advantages derivable from it, and its Present Position and Future Development." It was full of interest and instruction, Mr. Greig's opinion is that the generality of land, if put under steam-cultivation, and kept free from the trampling of animals, would only need one deep working every fourth or fifth year. He confidently expects that, with remodelled farms, the use of the best engines and machinery, and the employment of men educated to superintend them, the expense of cultivation would be reduced to one-half of the present cost. Mr. Fernie said that the best way of avoiding the breakages of machinery referred to by Mr. Greig, was to introduce the use of steel, and properly tested wire rope. The first wire rope was worn out with 300 miles' work, but rope now made of steel wire will do fifty times as much work.

The Rev. Patrick Bell, of Carmyllie, Forfarshire, the original inventor of the reaping machine, read a paper on "Reaping

Machinery." It was a most graphic account of the history of his experience, which, in the year 1826, led to the invention. Mr. Fairbairn stated that he had been engaged at the Paris Exhibition to report on reaping machines, and that he had seen 15 or 16 machines tried on a large farm, and that the best, an American invention, differed but very little from Mr. Bell's.

Mr. J. Clerk Maxwell's paper on "The Theory of Diagrams of Forces as applied to Roofs and Bridges," was very theoretical, and had an interest for but a limited number of persons.

In reference to the Report of the Committee on the Patent Laws, the President announced that it was not ready, owing to the absence of the members in London and Paris, during July and August, but considerable progress had been made with it, and the Committee was re-appointed.

A highly important paper was read by Dr. W. Fairbairn on "Experimental Researches on the Mechanical Properties of Steel in its present improved state of Manufacture." The introduction to the paper gave a condensed history of the improvements lately made in the manufacture of iron and steel, and referred to the attempts to substitute steel for iron in the construction of boilers, bridges, &c., on account of its greater tenacity and security. Dr. Fairbairn discourages the placing of too much reliance on steel until the present difficulties of its manufacture are surmounted, and until it can be produced with as much uniform certainty as iron. Time and close observation of facts would overcome the difficulties now experienced. The author's experiments had been specially directed to the determination of the following points:—1. Transverse Strain. 2. Tensile Strain. 3. Economic use of Material. 4. Compression. 5. Comparison of Tensile and Compressive Resistances; and they had enabled him to announce many results of the utmost importance.

One of the very few representatives of American science at Dundee was General Haupt, whose boring and tunnelling machine has recently excited a large amount of attention in this country. The inventor gave a full and elaborate description of his machine, and illustrated it by diagrams. The machines weigh 125 lbs. each, are only 30 inches long, 6 inches wide, and 8 inches high. On the subjects of power by compressed air, ventilation, and use of steam in tunnelling, General Haupt's statements excited much interest, and drew forth very complimentary remarks from General Lefroy, Dr. Fairbairn, and the President, the latter expressing a hope that he would again favour the British Association with his presence. Dr. C. Le Neve Foster followed General Haupt with an account of a boring machine used at the Preseberg Mines in Sweden.

A paper by Mr. Joseph Mitchell, C.E., on "A New Mode of Constructing the Surface of Streets and Thoroughfares," excited

some attention in Section G. Mr. Mitchell's new plan is to lay down a bed of three inches of cement-concrete to the required convexity of the street, and then to build on this bed a layer of paving-stones five inches deep and three inches wide, filling up the joints with cement-grout. As tested in Inverness and on George IV. Bridge, Edinburgh, this new system has proved so successful that many advantages are claimed for it as regards durability, cleanliness, repairs, &c. Mr. Mitchell recommends the best Portland cement for the concrete.

"An Iron Camb for Power-Looms" was the subject of a paper by Mr. James K. Caird, of Dundee. One was read by Sir Edward Belcher on "The Methods for Testing the Speed of Vessels over the Measured Mile;" another, by Mr. J. R. Napier and Professor Rankine, discussed "The Use of Movable Seats for Slide-Valves;" and one by Mr. Lewis, of Dublin, had for its subject "An Improved Marine Steam Boiler." Mr. S. J. Mackie also read a long and elaborate paper on "Iron Floating Forts, Iron Harbours, and other Floating Structures, and on Daft's Method of Construction of Iron Fabrics." Other papers of more or less interest followed, and there were also two of a mechanical character read in Section F, because they were considered to be of an economic or statistical character: their subjects were "The Engineering Trade of Dundee," and "The Iron Shipbuilding of Dundee."

THE PUBLIC HEALTH.

(With the Proceedings of the Health Section of the Social Science Association.)

WHATEVER may be the result of the elections to Parliament under the new Reform Bill, there is one comfort in the prospect that our sanitary legislation can hardly get to a lower ebb than it is just now. It is perhaps to be hoped that as the people who have now the electoral power conferred upon them are those who suffer most from bad sanitary arrangements, this subject will not wholly escape their attention in the selection of candidates to represent them in Parliament. If this be the case we may hope to see some men returned who have a notion of the value, economically we mean, of human life, and who will apply themselves to introducing law and order into that chaos of conflicting legislation, which a well-meaning but incapable legislation has introduced for the purpose of preserving the health and lives of Her Majesty's lieges.

In our last number we referred to the Vaccination Bill and Mr. Torrens's Artizans' Dwellings Bill: the latter was withdrawn at the eleventh hour from pressure of business, whilst the former is now passed into law with all its defects. It is to be hoped that it may do good. It is, however, encumbered with a principle that is new to our legislation. Should the medical profession agree to take the Government eighteen pence for vaccination, if they do the thing well at this price, they are to have the chance of getting rewarded by an extra payment. The "payment by result" scheme of South Kensington is to be tried in vaccination, and the medical men who do this duty very well are to be rewarded as good boys at school,—with prizes. This plan is nothing more nor less than an acknowledgment that the sum offered for vaccination is no professional recompense, and that if medical men will undertake the operation for the small sum offered, they shall be rewarded if they perform the operation properly, which there is no right to expect at the price they are paid. We hope the medical profession will universally spurn this bribe, and show the Government that they can perform their duties without such a stimulus. We should like to see the President of the Privy Council, its Vice-President, and Medical Officer put on a system of "payment by results," before it is introduced amongst the great body of the medical profession.

The ninth annual report of the medical officer of the Privy Council has been printed, and two journals, the 'Pall Mall Gazette'

and the 'Lancet,' have had notices of it, but up to the present time no copy of the report can be obtained at the Queen's printers. Mr. Simon is said to give an elaborate account of the stages by which the present Vaccination Bill has assumed its present form, and also a defence of the presenting gratuities for results.

The most interesting portion of the report appears to be the appendix, in which is published a paper by Dr. Buchanan "On the Results of Sanitary Improvements, as applied to the Large Towns of England." The 'Lancet' remarks on this paper, without giving any reason for its opinion, that it "is undeniably one of the most important contributions to state-medicine which has been made for many years." In a postscript to his report Mr. Simon gives an account of his visit to the International Cholera-conference at Weimar. We quote from the 'Lancet' the conclusions at which Mr. Simon arrives. The local conditions of safety against cholera, and we may add typhoid fever, are—

"1. That by appropriate structural works, all the excremental produce of the population shall be so promptly and so thoroughly removed that the inhabited place, in its air and soil, shall be absolutely without fæcal impurities; and 2, that the water-supply of the population shall be derived from sources and conveyed in such channels that its contamination by excrement is impossible."

The last volume of the 'Transactions of the Social Science Association' contain two papers "On the Medical and Legal Aspects of Sanitary Reform," by Dr. A. P. Stewart and Mr. E. Jenkins, which have recently been published by Hardwicke in the form of a pamphlet. Dr. Stewart's paper is the result of a very elaborate inquiry into the sanitary condition of our large towns, and contains a number of tables giving a summary of information obtained by sending a series of printed questions throughout the country. The impression produced by the study of Dr. Stewart's paper is very painful. Throughout the length and breadth of the land people pay no attention to the prevention of disease and death. The local authorities neglect to put in operation the provisions of the various Health Acts. A list is given of thirty-six towns in England (at the head of which is Birmingham, with a population of 340,000), containing above two and a half million of inhabitants, in which there is no medical officer of health. In many of these towns there is a death-rate of from 25 to 30 in the 1,000; in a large number the drainage is imperfect; and in many typhoid (drain) fever is never absent. Water is constantly supplied from wells in communication with cesspools, and in many instances water is supplied for public use, known to be contaminated with sewage. That decent English people, cultivating in many cases the excessive refinements of life, should allow themselves to live, and their families to grow up, amongst such a mess of nastiness is astonishing, and

one is at a loss to know how to reach them to warn them of their folly and their danger. Dr. Stewart recommends the appointment of "a thoroughly efficient administrative department of government for the superintendence of all matters relating to the public health," and the "appointment of officers of health, not only in towns but in the country, and for our ports and harbours."

Mr. Jenkins commences his paper by a truism, which, one would think, should have stirred even the apathy of a London vestry,—"PUBLIC HEALTH IS PUBLIC WEALTH." This sentence should be printed in letters of gold over every vestry-house, every corporation-hall, and every law-court in the kingdom. It is the law of human civilization, and is the key to all human progress. Mr. Jenkins shows very ably in his paper, how wretchedly all our sanitary laws fail on account of their permissive character; and how, by the indifference and ignorance of local boards, the health and wealth of the community are sacrificed.

We are glad to be able to say that a medical officer is *at length* about to be appointed by the Manchester authorities, who are trying to justify their opposition to the Artizans' Bill by attacks upon Mr. Torrens. The truth is, that if the Manchester Corporation had been as zealous in promoting as they were in opposing Mr. Torrens's measure, he would not have been obliged to defer it until next Session.

In strange contrast with the conduct of the Manchester Corporation, we may add that a memorial was sent up to Lord Derby (through Lord Stanley, who interested himself in this, as he does in every effort to promote the welfare of the masses), signed by leading sanitarians in Leeds, Liverpool, Manchester, and Oxford, to urge the passing of the Bill; and, if needful, the same gentlemen will repeat their efforts in co-operation with Mr. Torrens next year.

There is some little satisfaction in witnessing the wretched attempts at justification put forward by the Manchester authorities, for it shows that at least they are conscious of having done wrong, but we hope soon to see some more creditable evidences of their desire to protect the health and lives of their citizens. They have acted upon the principle usual with corporations: to resist reform until public opinion seemed likely to overwhelm them, and then, tardily complying with the public requirements, have comforted themselves by abusing their friends and advisers.

The Social Science Association held its Eleventh Annual Meeting this year at Belfast, under the presidency of Lord Dufferin. The session was opened by an address from the President, which dealt very boldly with the social grievances of Ireland. As no allusion was made by his Lordship to public health, a subject on which our legislators generally seem to take very little interest, we need not refer to it further here. Sir James Simpson, of Edinburgh, had

accepted the office of President of the Health Department, but unavoidable engagements prevented the Doctor from taking the chair the first few days of the Congress. According to the plan generally adopted by the Association, certain questions were proposed to be discussed, and papers bearing on them read. The chair was taken on Thursday by Dr. Lankester, who opened the meeting with some remarks on the question to be discussed: — What measures are necessary to secure efficiency and uniformity in the working of the sanitary laws throughout the kingdom? He drew especial attention to the want of anything like central authority for health-matters in the offices of the Government. He pointed out the different health-functions performed by the Registrar-General, the Poor Law Board, the Home Secretary, and the Privy Council; also the various local boards, such as vestries, boards of guardians, corporations, town councils, and sanitary committees, which were organized to carry into effect the multitudinous and contradictory Acts of Parliament, which proposed to give some people permission to preserve the health and life of others. Three papers were read on the general question: the first by W. H. Michael, Esq., the second by Dr. Elliott, of Carlisle, and the third by W. B. Caulfield, Esq. A very interesting discussion followed the reading of the papers. Dr. Stephenson McAdam, of Edinburgh, said that an Act had been passed for Scotland during the last session of Parliament, putting it in the power of any ten inhabitants to complain of nuisances, and also enabling them to insist on the local authority performing the necessary works, and compelling the owners of the property to pay for them. Dr. Browne stated they had no health officer for Belfast. Dr. Trench defended the action of the Corporation of Liverpool in health-matters, and thought their fault was a tendency to do too much in that direction. The result of the discussion was in favour of some plan by which there should be a central board or officer having a power of watching over the health-interests of the whole population. Every speaker was in favour of appointing medical officers of health for both town and country districts. Several of the speakers expressed themselves very strongly on the difficulty of proceeding in certain cases of nuisance under the various health-acts. Dr. Morris, of Baltimore, U.S., surprised the meeting somewhat by stating that they had no sanitary laws in America, and that the inhabitants of the large towns of America carried out all necessary sanitary actions of their own accord. In Baltimore, for instance, they had a board of health composed entirely of medical men, who, by the sanction of the inhabitants, exercised quite arbitrary powers. The board appointed two medical men as health-officers, and every policeman was made an inspector of nuisances. Whenever the police discovered a

nuisance they reported to the officer of health, and legal steps were then taken, if necessary, to remove the nuisance, but there was no imperial authority in sanitary matters.

On Friday the question submitted for discussion was, "In what respects do the Registration Systems of England, Ireland, and Scotland need improvement, and is it desirable they should be assimilated?" This question was opened by an excellent paper from Dr. Arthur Ransome, of Manchester. After alluding to the system of registration of births and deaths, and the census-returns of the Registrar-General, he pointed out the uncertainty of the results, as far as life and health were concerned, founded upon such data. He dwelt more particularly on the disturbing elements of immigration and emigration in the large towns of England and in counties, the importation of cattle increasing largely the death-rate of some districts. He suggested that, in addition to the information already obtained, the duration of the residence of the persons in the district in which they died should be recorded. He pointed out that in England neither the registration of births nor that of deaths was compulsory, and showed the unsatisfactory nature of the returns of causes of death obtained by voluntary means. He urged also the necessity of registering the births of still-born children, as crime might be extensively committed under the present system. He concluded by recommending that a registration medical officer should be appointed in each superintendent-registrar's district, whose duty it should be to verify death, who also might be the medical officer of health and the assessor in the coroner's court. Dr. Lankester gave some reasons for thinking it would be an especial advantage in the coroner's court to have as an assessor a person specially educated, whose duty it should especially be to conduct *post-mortem* examinations, and report upon them to the coroner and jury. Mr. Cengenven spoke of the defective registration of the births of illegitimate children, and stated as the result of his own inquiries that only 46 out of 140 illegitimate children were registered. He thought if a certificate of birth could be required before a burial-warrant was granted, that it might induce a larger number of registration of births.

Dr. McCrae, the Registrar of Belfast, stated that the poor registered the birth of their children more regularly than they did their death. He stated that in the Irish Registration Act there was no connection between the death and the burial, and the burial-warrant was not granted as the result of the registration of the death. The death was required to be registered within seven days, and the Registrar had power to demand a certificate, but many persons were buried, especially in country districts, without any registration or burial-warrant at all. Captain Clode, of the General Registrar's Office in London, stated that the causes of death were

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efficiently registered in London in 95 per cent. of all the deaths registered. In the country the proportion of deaths satisfactorily registered was much less. He stated with regard to compulsory registration that people in England regarded inquiries into domestic matters, such as births and deaths, as unnecessarily interfering with their private affairs, and it was in deference to this feeling that legislation had not proceeded further. At the conclusion of the discussion the chairman, Dr. Lankester, was requested to bring before the Council of the Association the deficiencies of the English Registration Act in relation to compulsory registration of births and deaths, and also the necessity for requiring in Ireland a medical certificate of the cause of death before permission was given to bury the body.

On Saturday Dr. Lankester read a paper on "Prison and Workhouse Dietaries."

On Monday the question discussed in the Health Section was, In what form and to what extent is it desirable that the public should provide means for the recreation of the working men? This question was opened by a paper from Dr. Hardwicke, of London. In the course of his remarks he recommended that public parks should be formed for the purposes of recreation, more especially for the sedentary classes of the population. Reading rooms, with indoor amusements, were better adapted for those who had been engaged in open-air occupations. He urged the necessity of recreation being encouraged on the Sunday, and recommended that reading rooms be opened, and lectures be given on that day. He suggested the formation of parks, working men's clubs, and other places of recreation to be supported out of the rates of the parish. A paper was also read by Miss Barham Corlett, in which she strongly recommended the formation of city playgrounds for children. A long discussion followed, in which various opinions were expressed as to the best way of providing the means of recreation. Mr. McAdam said that in Edinburgh the science classes, in connection with the School of Art, had succeeded. Mr. Airlie, of Glasgow, maintained that the working man needed amusement rather than instruction, and that in Glasgow weekly concerts and soirées had perfectly succeeded. Dr. Burtlett thought the working man should be allowed at his club to take a limited quantity of beer if he wished. Dr. Lankester advocated the introduction of unfermented beverages in our public parks. To drink was a very natural desire, and men were not satisfied with cold water, especially where it was dangerous, and he thought the teetotalers ought to devise some refreshing beverage that was palatable, and could be sold at the same price as London porter.

Sir James Simpson, Chairman of the Health Section, delivered his address on Tuesday Morning. There was a crowded audience.

The address was delivered extemporaneously. He began by describing man as the only animal that surrounded himself with filth and dirt, and by his own neglect shortened those days of existence which his Creator intended him to enjoy. He dwelt with great energy on the necessity of all classes, high as well as low, seeking to surround themselves with an atmosphere of pure air. He showed the dreadful effects of this neglect by the long list of preventable diseases which carried off people in England and Ireland, and which amounted to a number of not less than 120,000 persons annually in the three kingdoms. He showed how the houses of the rich as well as the poor were poisoned by the neglect of drainage and ventilation. He then drew attention to the mortality of hospitals as an illustration of the danger of impure atmospheres. He said the mortality of infants and mothers in lying-in hospitals was seven times as great as out of hospitals. He adduced statistics to show that in medical and surgical hospitals the death was much greater than in the humblest homes. He brought forward the experience of the American war in favour of the treatment of soldiers in camps and in temporary hospitals, as compared with the more costly and permanent kinds of hospitals. He then advocated the system of building Village Hospitals, in which not more than one or two cases should be treated in the same room. The subject of Smallpox was next referred to; and the fact alluded to, that 25,000 people had died of smallpox in the United Kingdom during the past four years. He considered this a disgrace to the intelligence and humanity of the country. He was afraid that we were barbarous enough to admire more those who destroyed the lives of our fellow-creatures than those who saved them. France had erected a monument to the memory of Jenner, that greeted every Englishman when he planted foot on her shores; and England had once set up a statue to Jenner, and placed it with her military heroes in Trafalgar Square, but had now allowed it to be cast away nobody knows where. No wonder that the Government which could thus insult the memory of Jenner, should allow the country to be smitten with the disease he had shown them how to prevent.

The remainder of Tuesday was employed in the discussion of the sanitary condition of Belfast. From two papers that were read, one by Dr. Browne and the other by Mr. Penworth, both of Belfast, it appears that this town is much in need of sanitary improvement. It appears that the death-rate was last year from 30 to 33 in the thousand. Accurate statistics cannot be got in Ireland, for reasons that have already been referred to in this report. The water is bad, the drainage is defective, the houses are overcrowded, the graveyards are full; and thus Belfast offers one of the finest fields in the United Kingdom for the exertion of sanitary philanthropy.

At the same time it might be mentioned that Belfast is about to be improved. Instead of taking part of its water from the filthy Lagan, it is about to extend its waterworks, so as to get pure water from the limestone hills with which it is surrounded. It is about to shut up its out-door graveyards, and to open a park for the recreation of the people. If the Social Science Congress should do nothing more than quicken the authorities of Belfast in their intentions to save their population from the suffering and death with which it is now afflicted, it will have done a work which will give it strong claims on the regard and sympathy of Belfast as long as it shall be a city where human beings are striving to realize the highest blessings of a kind Providence.

Quarterly List of Publications received for Review.

1. British Conchology; or, an Account of the Mollusca which now inhabit the British Isles and the surrounding Seas. Vol. IV. Marine Shells. By John Gwyn Jeffreys, F.R.S., F.G.S. Post 8vo., cloth. 487 pp. *With nine Plates.* *Van Voorst.*

2. Sound. A Course of Eight Lectures delivered at the Royal Institution of Great Britain. By John Tyndall, LL.D., F.R.S. 340 pp. Post 8vo. 169 *Wood Engravings.* *Longmans & Co.*

3. Elements of Chemistry: Theoretical and Practical. By Wm. Allen Miller, M.D., LL.D., V.P.R.S., Professor of Chemistry in King's College, London. Part I. Chemical Physics. Fourth Edition. 660 pp. 8vo. 274 *Wood Engravings.* *Longmans & Co.*

4. A Handybook to the Collection and Preparation of Fresh-water and Marine Algæ, Diatoms, Desmids, Fungi, Lichens, Mosses, and other of the Lower Cryptogamia, with Instructions for the Formation of an Herbarium. By Johann Nave. Translated and edited by the Rev. W. W. Spicer, M.A., F.R.M.S. *Hardwicke.*

5. The Science of the Weather, in a Series of Letters and Essays. By several Authors. Edited by "B." 382 pp. Post 8vo., cloth. *With* 16 *Charts and several Woodcuts.* *Glasgow: Laidlaw.*

6. The Medical and Legal Aspects of Sanitary Reform. By Alex. P. Stewart, M.D., and Edward Jenkins, Barrister-at-Law. 100 pp. 8vo. *Hardwicke.*

7. Inventors and Inventions. By Henry Dircks, C.E. 270 pp. Post 8vo. *E. & F. N. Spon.*

8. Arithmetic Simplified for General Use, and adapted to Students in any Departments of Science or Art, also to serve as a Supplement to the Author's 'Elements of Physics' and other Works on Popular Science. By Neil Arnott, M.D., F.R.S., Member of the Senate of the University of London, &c. 45 pp. 8vo. *Longmans & Co.*

9. Results of Astronomical Observations made at the Melbourne Observatory in the Years 1863-4-5, under the Direction of Robert L. J. Ellery, Government Astronomer to the Colony of Victoria. *With Plates.* 140 pp. Royal 8vo.

10. Memoirs of the Geological Survey of Great Britain and of the Museum of Practical Geology. Mineral Statistics of the United Kingdom of Great Britain and Ireland, 1866. By Robert Hunt, F.R.S., Keeper of the Mining Records. *Stanford*, 1867.

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Drift Sections of the Holderness Coast. By Hugh F. Hall, F.G.S. *Liverpool Courier Office.*

On the Elimination of Nitrogen by the Kidneys and Intestines during Rest and Exercise, on a Diet without Nitrogen. By E. A. Parkes, M.D., F.R.S. 17 pp. 8vo.

On the Elimination of Nitrogen during Rest and Exercise on a Regulated Diet of Nitrogen. By E. A. Parkes, M.D., F.R.S. 15 pp. 8vo.

On the Distribution of Temperature in the Lower Region of the Earth's Atmosphere. By Henry Hennessy, F.R.S., M.R.I.A. 58 pp. 4to. *Dublin: M. H. Gill.*

The River of Life. By James Biden. 24 pp. 8vo. *Gosport: Legg.*

A Technical Institution for Leeds and District. Proposed by George Henry Nussey and Arthur Nussey. 16 pp. 8vo.

Letter to His Grace the Duke of Buccleuch on the Quadrature and Rectification of the Circle. By James Smith, Chairman of the Liverpool Local Marine Board. 70 pp. 8vo. *Liverpool: E. Howell.*

On Steam Boiler Explosions and their Records, and on Inspection as a Means of Prevention. By Edward B. Marten. 50 pp. Demy 8vo. 13 *Plates.*

Notes on the Climate of Victoria. By Robert L. J. Ellery, Government Astronomer of Victoria. 16 pp. 8vo.

Mimicry and other Protective Resemblances among Animals. By Alfred R. Wallace. Reprinted from the 'Westminster.'

Santorin, the Kaimeni Islands from Observations by Fritsch, Reiss, and Stübel. Translated from the German. With 2 Photographs and 2 Maps. 7 pp. 4to. *Trübner & Co.*

A Preliminary Notice of the Akazga Ordeal of West Africa. By Thos. R. Fraser, M.D., F.R.S.E. 8 pp. 8vo.
London : J. E. Adlard.

A Summary of the Occurrences of the Grey Phalarope in Great Britain during 1866. By J. H. Gurney, jun. 24 pp. 8vo.
V. Voorst.

Clinical Lectures on Diseases of the Skin. Numbers 3 and 4. By Balmanno Squire, M.B., F.L.S. With Photographs and Letterpress. *Churchill & Sons.*

Transactions and Proceedings of the Royal Society of Victoria. Part 1, Vol VIII.

Transactions of the Woolhope Naturalists' Field Club, including the First Part of the Flora of Herefordshire. By the Rev. W. H. Purchas, L.Th. With Map of Herefordshire and 7 Illustrations, chiefly Photographs. 321 pp. 8vo., cloth.
Hereford : Wm. Phillips.

Address to the Royal Geographical Society of London at the Anniversary Meeting. By Sir Roderick I. Murchison, Bart., President. 52 pp. 8vo., sewed. *London : Clowes & Sons.*

On the Change in the Obliquity of the Ecliptic : its Influence on the Climate of the Polar Regions and Level of the Sea. By Jas. Croll.

Address to the Geological Section of the British Association. By A. Geikie, F.R.S., President of the Section.

The Glasgow University Calendar for the Years 1867–8.

The Transactions of The Royal Society of Victoria (President's Address, 1867).

The Canadian Naturalist and Geologist.

The Geological Magazine.

Le Mouvement Médical.

The Scientific Journal, Philadelphia.

The American Naturalist.

The Westminster Review.

Report of the Liverpool Naturalists' Field Club, 1867.

Symons's Monthly Meteorological Magazine.

Proceedings of the Royal Society.
" " Royal Astronomical Society.
" " Chemical Society.
" " Geological Society.
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The Editors will be glad to receive the Printed Proceedings of Local Boards of Health, and of other Sanitary Corporations, to which due consideration will be given by the Editor of the Quarterly Article on the Public Health.

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